Using HeadSprout Early Reading with a child with Autism Spectrum Disorder: An examination of phonological awareness, participant engagement, and participant enjoyment

Caitlin Freeman, B.A.

Applied Disability Studies

Submitted in partial fulfillment
of the requirements for the degree of

Masters of Arts in Applied Disability Studies

Faculty of Graduate Studies, Brock University

St Catharines, Ontario

Acknowledgements

I would like to express my gratitude to several people who made it possible for me to complete this research. First, I would like to thank my co-supervisors Dr. John McNamara and Dr. Tiffany Gallagher whose encouragement and guidance has helped shape my thesis. The continued support and expertise you have provided over the past two years has given me a unique opportunity to pursue research that inspires me to grow as a clinician and an applied researcher. Thank you also to my committee member Dr. Frances Owen and external examiner Dr. Lynn Dempsey, for your invaluable and insightful feedback on my thesis.

I would also like to extend my thanks to Whitney Kerr. Your time and effort in assisting as a second observer for this study is greatly appreciated.

Lastly, I would like to take the opportunity to express my utmost gratitude to my family who have supported and encouraged me throughout the entire research process. Your understanding, patience, and love continues to inspire me to pursue my academic and professional aspirations. Thank you also to my extended family and friends, I appreciate your support from near and far.

Table of Contents

Abstract

This study examined the effectiveness of a 9-week reading program in improving the phonological awareness (PA) skills of a seven year old boy with Autism Spectrum Disorder (ASD), Attention Deficit Hyperactivity Disorder (ADHD), and Oppositional Defiant Disorder (ODD). The study's secondary goal was to describe how the participant engaged with and enjoyed the HeadSprout computer program. The participant attended a one hour reading program incorporating 30 minutes of HeadSprout Early Reading three days a week for 9 weeks. Results demonstrated that the participant's PA scores increased from the 16th percentile at pre-test to the 35th percentile post program. Four of five measures of PA increased, segmenting nonwords decreased to the 2nd percentile post program. Momentary time sampling procedures revealed the participant was engaged with the computer program 94.5% of the time. Perceived ratings of enjoyment indicated the participant enjoyed using the program. Specific components of the program which may have influenced participant enjoyment and engagement are discussed. Study limitations and implications of these findings are discussed in reference to future research.

Chapter 1

Introduction

Reading is an essential skill that enables children to learn, to secure employment when older, and to function within modern society. Some researchers have stated that to be a successful reader, one must have "the ability to accurately and fluently decode words so as to comprehend their meaning in isolation and in context" (Huemer & Mann, 2010, p. 485). Reading acquisition therefore requires and depends on these two essential skills: the ability to identify sounds (phonological decoding; PD), and the ability to be aware of and manipulate the sounds within words at the phoneme and syllable level (phonological awareness; PA) (Smith Gabig, 2010). Students demonstrating difficulty with either of these skills may struggle learning to read.

Acquiring reading skills may be a difficult learning curve for any child, let alone a child diagnosed with Autism Spectrum Disorder (ASD). Current research demonstrates high variability in the reading skills of children with ASD, where some children may have relatively intact decoding skills, and others may be poor at reading words and nonwords (Grigorenko, Klin, & Volkmar, 2003; Huemer & Mann, 2010; Nation, Clarke, Wright, & Williams, 2006). Researchers have also found that deficits in phonological processing, specifically in phonological awareness, may be a significant contributing factor to poor reading skills among children with ASD (Asberg & Dahlgren Sandberg, 2012). Teaching children with ASD to read should target phonological decoding (PD) or phonological awareness (PA), or both and consider the unique learning needs of each individual student (Ontario Ministry of Education, 2005).

Research demonstrates that reading programs which include PA instruction, contribute to word reading ability, decoding skills, comprehension, and later reading success for students with and without reading or learning disabilities (Gray & McCutchen, 2006; Hogan, Catts, Little, 2005; Melby-Lervåg, Lyster & Hulme, 2012; Phillips, Clancy-Menchetti & Lonigan, 2008).

One-to-one computer based programs incorporating PA and PD instruction, accompanied with small group or whole classroom lessons have also demonstrated improvements in PA and PD scores for children with ASD from pre- to post-test (Whalon, Otaiba, & Delano, 2009). Researchers and practitioners have additionally discussed the utility of electronics and computer programming to assist with student interest and engagement. When children are interested and engaged with the materials they are reading, they are provided with learning and practice opportunities, which contributes to positive reading outcomes (Baroody & Diamond, 2014; De Naeghle, Van Keer, Vansteenskiste, & Posseel, 2012; Guthrie, Klauda, & Ho, 2013; Jones & Brown, 2011). Incorporating electronic screen media within instruction for example, has demonstrated to increase the engagement of students with ASD during instruction (Heimann, Nelson, Tjus, & Gillberg, 1995; Mineo, Ziegler, Gill, & Salkin, 2009; Pennington, 2010; Williams, Wright, Callaghan & Coughlan, 2002). If students with ASD are interested in and able to maintain attention with the instructional material, then screen based technology holds considerable promise as an instructional tool for individuals with ASD.

Overall, effective reading programs for children with ASD and reading difficulties must begin early, focus on PA and PD skills, incorporate student interests and engagement, in addition to considering the social, cognitive, and oral language deficits that may co-occur with ASD (Bryson, Corrigan, McDonald & Holmes, 2008; Kozlowski, Matson & Belva, 2012; Lunsky, Lake, Balogh, Weiss & Morris, 2013).

One computer-based reading program, *HeadSprout Early Reading* (HeadSprout), has demonstrated promise in developing early reading skills for typically developing children (Layng, Twyman, & Stikeleather, 2004). Improving 90% of its users' ability to read among TD children, HeadSprout holds promise as an instructional tool to develop the reading skills of children with ASD (Layng et al., 2004). Preliminary research on HeadSprout Early Reading and children with ASD suggests this program may be an appropriate method for teaching early

reading skills to this specific population (Grindle, Hughes, Saville, Huxley, & Hastings, 2013; Whitcomb, Bass, & Luiselli, 2011).

A gap in the literature warrants an investigation of engagement, enjoyment, and improvements on measures of phonological awareness while using HeadSprout Early Reading for readers with ASD experiencing difficulty learning to read. The purpose of this research project was to describe the effectiveness of a 9-week HeadSprout-based reading program in improving the phonological awareness (PA) skills of a seven year old boy with ASD, Attention Deficit Hyperactivity Disorder (ADHD), and Oppositional Defiant Disorder (ODD), and to describe how the participant engaged with and enjoyed the HeadSprout computer program. This study specifically proposed three research questions:

1) Does HeadSprout Early Reading significantly improve the phonological awareness score of a child with ASD?
2) How does the child engage with HeadSprout Early Reading?
3) Is HeadSprout Early Reading an enjoyable reading activity for a child with ASD?

Chapter 2

Literature Review

The Canadian Government (2008) states that reading and writing are, "…fundamental for learning in school…impact[s] on an individual's ability to participate in society…and it provides the foundation upon which skills needed in the labour market are built" (Government of Canada, 2008, para 4). The ability to read is an essential skill that enables children to learn, to secure employment when older, to function within modern society, and in general, contributes to success later in life.

Reading acquisition for children, typically developing or otherwise, is important for their future success. Researchers have found that strong readers have been found to read more, and acquire better literacy skills, vocabulary, and knowledge than their poor reading counterparts (Lonigan, Purpura, Wilson, Walker, & Clancy-Menchetti, 2013). Furthermore, reading is a complex cognitive skill that children require to successfully access the school curriculum (Jacobs & Richdale, 2013). As the focus in school shifts from "learning to read" to "reading to learn", students experiencing difficulty learning to read are unable to read to learn; ultimately compromising their ability to keep up with grade demands within school (Norbury & Nation, 2011). In comparison, children with early reading success demonstrated better long term educational and occupational attainment in both service and manufacturing jobs than those with poor reading skills (Lonigan et al., 2013; Jacobs & Richdale, 2013).

Over the last 40 years, considerable research has been conducted on reading acquisition for children, with a particular focus on supporting the individual needs of all learners. Researchers have examined specific prerequisite reading skills and their role in assisting children to acquire strong reading and spelling skills; specifically, phonological awareness is a distinct and vitally important skill which facilitates the acquisition of early reading skills and later reading and spelling success (Castles & Coltheart, 2004; Gray & McCutchen, 2006; Hogan et al.,

2005; Melby-Lervåg et al., 2012; Schuele & Boudreau, 2008; Wagner, Torgensen & Rachotte, 1994; Yopp & Yopp, 2000). To be an effective reader, one must demonstrate phonological awareness by identifying, using, and manipulating the sounds within words (Smith Gabig, 2010). Poor readers or readers with learning disabilities characterized by poor phonological awareness skills can best be supported through early, individualized reading instruction which focuses on both phonological awareness and phonics (Castles & Coltheart, 2004; Gray & McCutchen, 2006; Hogan, Catts, & Little, 2005; Melby-Lervåg, Lyster, & Hulme, 2012; Schuele & Boudreau, 2008; Wagner, Torgensen, & Rachotte, 1994; Yopp & Yopp, 2000).

Effective reading instruction for students with intellectual disabilities or developmental disabilities, such as Autism Spectrum Disorder (ASD), must teach these skills in a way that is clear, simple, and meaningful. Several researchers have advocated for the use of technology in teaching children with ASD skills such as reading (Grindle et al., 2013; Pennington, 2010; Whitcomb et al., 2011; Williams, Wright, Callaghan & Coughlan, 2002). Instruction provided through or supplemented with technology, may help to address specific social and learning challenges that children with ASD may experience, thus paving the way for them to learn.

A review of the literature will clarify some incorrectly used terms, discuss and summarize current research findings from the fields of Autism Spectrum Disorder (ASD), education, literacy instruction, and reading disabilities with a focus on the reading among children with ASD and comorbid reading difficulties. This review will summarize components of effective reading instruction for this population and justify how a computer-based literacy program, HeadSprout Early Reading, is a promising teaching tool for students with ASD and poor reading skills.

Phonological Awareness

Phonological awareness in typically developing children occurs in a developmental sequence, progressing from larger units of sounds (syllables), to smaller onset-rime structures, to the smallest units of sound (phonemes) within words (Smith Gabig, 2010). The earliest and

easiest PA skill to develop is an understanding and ability to analyze the general sound structure of language, by identifying, matching, and generating syllables within words, and being able to rhyme (Schuele & Boudreau, 2008). As these early PA skills progress, a child's understanding of language, and the related skills become more complex and refined. Specifically, a child's skills evolve to understand, isolate, and manipulate individual sounds within language structure; this is phonemic awareness (Schuele & Boudreau, 2008). While both phonics and phonemic awareness are essential skills used to read, PA is a broader skill that plays a fundamental role in fostering and acquiring word recognition, decoding, and spelling accuracy for early readers (Castles & Coltheart, 2004; Gray & McCutchen, 2006; Hogan et al., 2005; Melby-Lervåg et al., 2012; Pennington & Lefly, 2001; Schuele & Boudreau, 2008; Smith Gabig, 2010; Wagner, Torgensen & Rashotte, 1994; Yopp & Yopp, 2000).

Review of Terms: Phonological awareness, phonemic awareness, and phonics.

Three distinct yet interrelated reading skills — phonological awareness (PA), phonemic awareness, and phonics — are often used incorrectly and interchangeably within the literature and practice. Clarification among these skills will enable researchers and practitioners to effectively develop and target specific skills to support reading development for at-risk or beginner readers experiencing difficulty.

Phonological awareness (PA) is a metalinguistic skill that "refers to the awareness of syllables and phonemes within spoken words and to the ability to manipulate the word at both the level of the syllable and individual phonemes" (Smith Gabig, 2010, p. 69). PA encompasses an explicit and deliberate awareness of the most basic units of speech sounds in language; this enables an individual to analyze and understand the sound or syllable structures within language and move beyond word meanings (Castles & Coltheart, 2004; Schuele & Boudreau, 2008). Phonological awareness is an overarching phonological skill that enables a person to understand and manipulate spoken words, syllables, onset-rime, and phonemes, beyond the ability needed in

everyday communications. Despite phonological awareness being independent from the reading process, PA can play a vital and possible causal role in reading acquisition (Castles & Coltheart, 2004).

A related skill often confused skill with PA, is phonemic awareness. This subset of PA encompasses the knowledge and skill of understanding, isolating, and manipulating individual phonemes within words (Smith Gabig, 2010). Phonemic awareness is a more advanced PA skill which plays an important role in developing a child's reading skills to help with word reading, decoding, and spelling accuracy (Hogan et al., 2005; Melby-Lervåg et al., 2012). In a meta-analysis of the processes responsible for developing children's word reading, Melby- Lervåg, Lyster and Hulme (2012) found that phonemic awareness skills may be one of the most important prerequisite skills for effectively learning to read for children with dyslexia – over rime awareness and verbal short term memory – indicating that phonemic awareness skills should be explicitly and directly taught during early stages of reading development. Castles and Coltheart (2004) have reported similar findings, where phonemic awareness was the strongest aspect of PA in predicting later reading and spelling success.

Phonological awareness is also distinctly different from and often confused with phonics; yet both skills are required to become a proficient reader. PA focuses on the ability to identify, analyze, and manipulate sounds and phonemes within spoken words, whereas phonics focuses on the alphabetic principle in print (Schuele & Boudreau, 2008). Phonics includes orthographic knowledge such as letter-sound correspondences specifically involving print, and is a required skill necessary for a child to learn to read. As a result, PA and phonics are reciprocal skills often taught together to teach children different sounds and relationships in both spoken and written language (Schuele & Boudreau, 2008). Reading instruction focusing on both PA and phonic skills can best support the literacy needs of students struggling with reading acquisition.

The Role of Phonological Awareness in Reading Acquisition.

Phonological awareness (PA) plays an important role in reading acquisition for all individuals. To be an effective reader, one must demonstrate the ability to identify, use, and manipulate sounds and phonemes within words (Smith Gabig, 2010). Several researchers argue that PA skills significantly contribute to word reading ability, decoding skills, comprehension, and later reading success for students with and without reading or learning disabilities (Gray & McCutchen, 2006; Hogan et al., 2005; Melby-Lervåg et al., 2012; Phillips, Clancy-Menchetti & Lonigan, 2008). Smith Gabig (2010), for example, reported that phonological awareness enables readers to decode unfamiliar words, and expand their ability to transform sight word vocabulary to speech (Smith Gabig, 2010, p. 69). Similarly, Melby-Lervåg et al. (2012) reported that strong phonological and phonemic awareness skills contribute to strong word reading skills. This indicates that for individuals to be strong and successful readers, they must be able to effectively read words and nonwords in order to comprehend the text they read. Ultimately, this suggests that strong PA skills are required for readers to effectively read words and, in turn, to comprehend what they read (Melby-Lervåg et al., 2012). A child's overall phonological awareness ability therefore plays an important role in their ability to decode new and unfamiliar words, and provides the foundation for strengthening other important reading skills required for successful reading acquisition.

A child's PA skills as early as kindergarten are also related to later reading achievement. Research demonstrates that children who experience difficulty decoding words have weak phonological awareness skills (specifically phonemic awareness) and most often demonstrate poor reading achievement in early grades; these children continue to struggle behind their peers by grade 5 (Gray & McCutchen, 2006; Schuele & Boudreau, 2008; Wagner et al., 1994). More specifically, strong PA skills predict early reading achievement as early as Grade 1, while poor PA skills indicate risk of, or diagnosis of a reading disability (Hogan et al., 2005; Schuele &

Boudreau, 2008). These findings emphasize the importance of using PA measures in kindergarten assessments to predict later word reading success, reading difficulties, or reading disabilities by grade 2 (Hogan et al., 2005). Taken together, PA not only holds powerful implications for the future reading achievement of school aged children, but also for adult readers; poor PA skills account for a large portion of variance in the reading skills of struggling adult readers (Schuele & Boudreau, 2008). These findings suggest that assessment and monitoring of PA skills as early as kindergarten can help target and support the reading development and maintenance of skills for those at risk of reading difficulties.

Effective Reading Interventions

Most children who have difficulty learning to read have core deficits in phonological awareness, despite other deficits in language, speech, or cognition (Bender, 2008; Pennington & Lefly, 2001; Phillips et al., 2008). Poor phonological processing, specifically PA and rapid automated naming (RAN), also appear to be core problems for children, adolescents and adults with reading disabilities (RD) (Pennington & Lefly, 2001).These difficulties can be prevented as early as possible through regular assessments of children's phonological awareness skills as early as kindergarten (Vervake, McNamara, & Scissons, 2007). Early assessments and identification can help teachers and practitioners identify students who may need extra support or more intensive instruction (Ontario Ministry of Education, 2007). By identifying students who score low on measures of PA, and students with a family risk to develop an RD, researchers and teachers can work together to best support the acquisition of phonological awareness skills, and to prevent poor reading and spelling despite average IQ and math achievement (Ontario Ministry of Education, 2007; Pennington & Lefly, 2001).

Early identification in kindergarten enables teachers, practitioners, and researchers to design and implement effective reading interventions focusing on PA skills for children at risk of a reading disability or already struggling with learning to read (Hogan et al., 2005; Phillips et al.,

2008; Schuele & Boudreau, 2008; Wagner et al., 1994). By identifying kindergarten students with PA scores below the 20th percentile, practitioners can scaffold appropriate reading interventions to improve overall reading and word decoding. Since children below the 20th percentile will often fail to acquire adequate PA skills and are often diagnosed with a reading disability despite receiving good classroom reading instruction, it is essential to provide these students with more explicit phonological awareness instruction (Melby-Lervåg et al., 2012). Reading interventions provided in earlier elementary grades have also demonstrated larger gains in PA scores, than when interventions are provided in later grades (Schuele & Boudreau, 2008). Other researchers support this notion, suggesting that students demonstrating poor PA skills in preschool and kindergarten should receive more intensive reading interventions as early as kindergarten or grade 1 (Melby-Lervåg et al., 2012; Phillips et al., 2008; Schuele & Boudreau, 2008; Torgesen et al., 1999). Together, research results demonstrate the importance of interventions beginning as early as possible, as this produces the most beneficial gains for children with reading difficulties.

Effective reading interventions for children demonstrating poor PA skills should also explicitly teach phonological awareness in its developmental sequence (Phillips et al., 2008; Schuele & Boudreau, 2008; The Regents of the University of Michigan, 2013). Specifically targeting PA and phonics tasks – such as sound matching, blending, segmenting, counting syllables, rhyming, and elision – prior to teaching the alphabetic principle and letter-sound correspondences, help to "facilitate the acquisition of reading and writing, specifically, decoding words and spelling words" (Schuele & Boudreau, 2008, p. 7; Smith Gabig, 2010; Yopp & Yopp, 2000). Researchers suggest that explicit teaching of these skills in small homogenous groups or in one-to-one formats encourages PA development and can lead to success with other literacy skills like phonics, decoding, letter name and letter sound knowledge, irregular phoneme knowledge, and the alphabetic principle (Phillips et al., 2008).

Researchers have also demonstrated that PA skills are a prerequisite skill to decoding words which demonstrates that PA training can lead to increases in decoding skills and overall reading for individuals with and without intellectual and reading disabilities (Schuele & Boudreau, 2008; Soltani & Roslam, 2013; Torgesen, Wagner, Rashotte, Herron, & Lindamood, 2010). In comparison to whole word reading instruction, researchers have found that PA reading interventions are more successful in improving performance on PA and decoding tasks (Schuele & Boudreau, 2008). Furthermore, research demonstrates that reading interventions for children with reading impairments are strengthened when they include 20-30 minutes of PA instruction focusing on single word and structure analysis, such as syllabic analysis and phoneme segmentation (Schuele & Boudreau, 2008). Lonigan, Purpura, Wilson, Walker and Clancy-Menchetti (2013) supported these claims, finding that code-focused interventions targeting PA skills for 20 minutes a day were effective in improving four measures of PA and other emergent literacy skills among preschool students (Lonigan, Purpura, Wilson, Walker & Clancy-Menchetti, 2013).

As evidenced in the literature, PA interventions are more effective than whole word reading instruction for children with and without intellectual and reading disabilities. Furthermore, short, daily PA instruction (20 to 30 minutes a day) can help to improve PA for participating children, but also help develop other essential skills that contribute to successful reading development.

Children with Reading Difficulties and Diverse Learning Needs

Many children experience difficulties learning to read. Children with a learning disability (LD), reading disability (RD), intellectual disability (ID), developmental disability (DD), and hearing or communication difficulties may experience difficulty learning to read, and may require educational support in different ways than typically provided for other children. This section will review current literature on the reading profile of children who may experience

difficulty learning to read, and discuss specific components to effectively tailor literacy instruction for these children.

Children with Learning or Reading Disabilities

Children with learning disabilities (LD) or reading disabilities (RD) are at risk for experiencing difficulty learning to read. Pennington and Lefly (2001) compared children at high and low risk for developing a reading disability (RD) across 3 years and found impairments in phonological skills for children at high risk for an RD, despite no group differences in IQ. Children at high risk for an RD were also found to be slower in acquiring the alphabetic principle, and other literacy skills in comparison to their low risk peers due to a genetic predisposition to phonological impairments (Pennington & Lefly, 2001). Together, research has indicated that poor PA skills as early as grade 1 indicate risk of a later diagnosis of reading disability (Hogan et al., 2005; Schuele & Boudreau, 2008). As school curricula transition from learning to read, to reading to learn, children with reading disabilities are at risk for falling behind their peers and experiencing global academic difficulties in later grades.

Children with Intellectual or Developmental Disabilities

Children with developmental or intellectual disabilities may also experience difficulty learning to read. Parents and teachers often presume that the source of their child's poor reading stems from their low IQ, however research by Soltani and Roslam (2013) suggests that deficits in specific areas such as phonological awareness may be responsible for poor reading among individuals with intellectual or developmental disabilities (IDD). This research also suggests that strong decoders also demonstrate stronger phonological awareness skills than those with weak decoding skills, indicating that poor PA skills may be responsible for poor word and nonword reading, decoding, and overall reading achievement among individuals with or without IDDs (Soltani & Roslam, 2013). Ultimately, this research demonstrates that PA (independent of other phonological processing skills) is a requirement for reading and decoding abilities among

individuals with intellectual or developmental disabilities (Soltani & Roslam, 2013).

Children with Autism Spectrum Disorder

Autism Spectrum Disorder (ASD) is a developmental disability specifically characterized by impairments in verbal and nonverbal communication, social interaction, and repetitive stereotyped behaviours (Bryson, Corrigan, McDonald, & Holmes, 2008; Kozlowski, Matson, & Belva, 2012). Prevalence rates have increased over the last two decades, and it was estimated in 2008 that 1 in 88 children were diagnosed with an Autism Spectrum Disorder according to the Diagnostic Statistical Manual IV-TR criteria (Bryson et al., 2008; Centre for Disease Control and Prevention, 2012; Dumas & Nilsen, 2003; Lunsky, Lake, Balogh, Weiss & Morris, 2013). As of May 2013, diagnostic criteria for Autism Spectrum Disorder requires individuals to demonstrate deficits in social communication and interaction, restricted and repetitive patterns of behaviour, activities, or interests, which appear early in the developmental period and significantly impair social and/or occupational functioning (American Psychiatric Association, 2013). Some of the difficulties experienced by children with ASD influence their ability to interact with others and how they acquire new skills, such as learning to read.

Several researchers have discussed how the social, cognitive, and oral language deficits often co-occurring with an ASD may contribute to a difficulty in acquiring reading skills. Norbury and Nation (2011), for example, discuss that the specific difficulties with social interactions experienced by children with ASD may interfere with their ability to relate and thus comprehend the text they are reading. Other researchers have noted that the desire for social exclusivity expressed by some individuals with ASD may foster hyperlexic abilities and poor phonological processing skills, which may in turn hinder the ability to read and comprehend text (Grigorenko et al., 2003; Smith Gabig, 2010). As a result, the social difficulties experienced by many children with ASD may hinder their learning and result in poor acquisition of specific reading skills. A more detailed examination of the reading development of children on the

Autism Spectrum is warranted to help educators understand specific challenges experienced by this population, and how best to support reading development through evidence based programming.

Influences of Oral Language on Reading Development.

Researchers have reported that several factors may contribute to the literacy success of children with an ASD. Norbury and Nation (2011) for example, examined how language impairment may influence the oral language and reading skills of children with ASD. In a 5-year longitudinal comparison of children with ASD and appropriate language skills, children with ASD and language impairments, and typically developing peers, Norbury and Nation (2011) found considerable variation in reading comprehension and decoding skills of the two ASD groups. Findings did not support precocious word reading abilities among individuals with ASD, which contradicts previous findings that children with ASD have superb decoding skills (Norbury & Nation, 2011). Further, the word reading skills of both groups of children with ASD diminished over four to five years, where children with ASD and language impairments were particularly vulnerable. As concluded by Norbury and Nation (2011), oral language abilities and reading deficits may have contributed to poor comprehension skills for all children with ASD.

Miniscalco and Dahlgren-Sandberg (2010) found similar findings among 5 children with ASD and language delays (LgD), where children with LgD and ASD scored significantly below the norm for single word comprehension and word decoding, and performed worse than children with LgD and Attention Deficit Hyperactivity Disorder (ADHD) and the comparison group of typically developing (TD) children with LgD. They also reported that children with ASD and a language delay demonstrated significantly worse skills on measures of phonological awareness, phoneme identification, phoneme discrimination, syntactical awareness, receptive grammar, word memory and morphological awareness than the comparison group (Miniscalco & Dahlgren-Sandberg, 2010). These findings indicate that children with late developing language

after 2.5 years old may demonstrate significant reading problems at age 8, and children with ASD and a language delay are particularly vulnerable. Lanter, Watson, Erickson, and Freeman (2012) supported these findings in an exploration of the emergent literacy skills of children with ASD aged 4 to 8. Their findings indicated that oral language abilities were moderately correlated with emergent literacy, emphasizing the important role of language in the development of early literacy for children with ASD (Lanter, Watson, Erickson, & Freeman, 2012). Davidson and Weismer (2014) reported similar results for 101 children with an ASD diagnosis, where nonverbal cognition and expressive oral language at two and a half years of age were predicative of early reading success at 5 and a half years of age (Davidson & Weismer, 2014). These results suggest that strong oral language and nonverbal cognition aid in reading development for children with ASD. Taking into consideration these factors, in addition to the literature on phonological awareness, oral language, nonverbal cognition, and phonological awareness appear to be important factors in supporting reading development for children with ASD.

Together these findings provide powerful insights into the reading abilities of children with ASD, specifically demonstrating that reading comprehension success is built on a foundation of strong oral language skills. These research findings provide further evidence that the reading abilities among children with ASD are quite varied, and that children with ASD who may appear to be decoding well and have oral language difficulties, may actually need additional support throughout school to properly develop successful word-level reading.

Hyperlexia.

Current research demonstrates that children with ASD demonstrate high variability in their ability to read, despite a belief that these children have quite similar literacy patterns (Asberg & Dahlgren Sandberg, 2012; Nation et al., 2006). Several researchers have concluded that all children with ASD have hyperlexic tendencies or relatively in-tact decoding skills, with

impairments in reading comprehension (Grigorenko, Klein, & Volkmar, 2003; Huemer & Mann, 2010; Nation et al., 2006; Newman et al., 2007; Norbury & Nation, 2011; O'Connor & Klein, 2004). This profile however, is often confused with hyperlexia (Asberg & Dahlgren Sandberg, 2013; Nation et al., 2006; Smith Gabig, 2010). Hyperlexia is defined as, "…an unusual preoccupation with letters and print, frequently developing precocious reading ability for age despite of lack of formal training" (Smith Gabig, 2010, p. 67). Hyperlexia has also been more broadly defined as an unusual ability with printed words, where the level of word recognition is significantly above the level of reading comprehension and cognitive functioning of an individual (Grigorenko et al., 2003; Newman et al., 2007).

In a review of the literature, Grigorenko, Kline, and Volkmar (2003) found that many researchers reported exceptional word-level reading and decoding skills among participants with ASD, with additional impairments in reading comprehension. Researchers have also estimated prevalence rates of hyperlexia among individuals with ASD to be as high as 5 to 10% (Grigorenko et al., 2003; Newman et al., 2007). While precocious word-level reading and decoding abilities may be common among individuals with ASD and hyperlexia, these children still demonstrate considerable reading difficulties beyond the single-word level (Grigorenko et al., 2003). In comparison to children with ASD without hyperlexia and typically developing age-matched peers, Newman et al. (2007) concluded that the reading of children with ASD and hyperlexia is characterised by a discrepancy between single-word reading and reading comprehension. Specifically, children with ASD and hyperlexia demonstrate significantly stronger single-word reading skills than children with ASD who were not hyperlexic, yet they perform equally to age-matched TD peers (Newman et al., 2007). Children with ASD without hyperlexia however, showed poorer overall reading, decoding, and comprehension in comparison to TD peers and peers with ASD and hyperlexia. Together, these findings indicate that not all children with ASD demonstrate hyperlexia, and that children with ASD and

hyperlexia read single words similarly to TD peers (which is characterised by a discrepancy between single word reading and reading comprehension).

Other researchers however, have argued that the reading profile of strong word decoding and recognition with poor reading comprehension among individuals with ASD is not a hyperlexic reading profile. Nation, Clarke, Wright and Williams (2006) for example, found that the overall mean scores within their sample of 41 children aged 6 to 15 with a diagnosis of Autism, atypical Autism, or Asperger's, the overall group mean scores fell within the normal range on reading accuracy (word reading, nonwords reading, decoding), and on average at least one standard deviation (SD) below population norms on measures of reading comprehension. This demonstrates that despite average reading accuracy for the sample of children with ASD, 65% of the sample demonstrated impairments in comprehension, where 38% scored more than 2 SDs below the mean (Nation et al., 2006). The most striking finding by Nation et al. (2006) was that 42% of participants scored at least one SD below population norms on nonword reading. This poor nonword reading demonstrates a difficulty with phonological processing, which research indicates is marked by a weakness or inability to read nonwords (Nation et al., 2006). Since researchers have found that children with ASD and hyperlexia are strong nonword decoders (Newman et al., 2007) and like their typical peers they rely on phonological decoding skills to read unfamiliar words, the participants in Nation et al. (2006) do not fit the hyperlexic profile.

Collectively, this research brings specific insight into the literacy profiles of children with ASD. Despite the common belief that most children with ASD are strong decoders, research by Nation et al. (2006) and Newman et al. (2007) demonstrates the need to support early reading acquisition and the development of decoding skills for children with ASD with and without hyperlexia. Further, children with ASD without hyperlexia appear to perform the worst on measures of single-word reading and reading comprehension indicating that they have weaker

phonological awareness, decoding and encoding skills than both their typically developing peers, and their peers with ASD and hyperlexia (Newman et al., 2007). This difference accounts for the poorer overall reading performance for children with ASD without hyperlexia compared to TD peers and peers with ASD and hyperlexia, suggesting a need for reading instruction and interventions to focus on and target these areas of weakness.

Word Reading Skills.

In contrast to the strong word reading and decoding skills reported for children with ASD and hyperlexia, many researchers report poor word reading among children with ASD (Asberg, Dahlgren & Dahlgren Sandberg, 2008; Asberg & Dahlgren Sandberg, 2012; Calhoon, 2001; Huemer & Mann, 2010; Nation et al., 2006; Newman et al., 2007). In a comparison of 77 children aged 7 to 15 with average IQ, Asberg, Dahlgren, and Dahlgren-Sandberg (2008), found that children with ASD demonstrated lower word reading, lower sentence reading comprehension and lower visual memory compared to their typically developing peers. Similarly, in a comparison of 15 teenagers with ASD and age-matched TD peers between 10 and 15 years old, Asberg and Sandberg (2012) found that the ASD group was not significantly weaker overall. Findings by Asberg and Sandberg (2012) revealed considerable variability in the reading skills of the ASD group, where a marked a distinction between poor and normal readers with ASD was apparent (Asberg & Sandberg, 2012). Specifically, normal readers with ASD did not statistically differ from the comparison group on any reading measures, however, poor readers with ASD performed significantly lower than the comparison group in reading, phonology, receptive vocabulary, and RAN (Asberg & Sandberg, 2012).

The most interesting finding within Asberg and Sandberg's (2012) research revealed that 33% of their sample with ASD demonstrated poor word reading and weak phonological processing skills in comparison to same-aged TD peers (Asberg & Sandberg, 2012). This indicates that while some children with ASD may demonstrate reading skills at similar levels to

typically developing peers, there is a portion of the ASD population who may experience significant reading difficulties due to impairments in phonological processing. Jacobs and Richdale (2013) reported similar results, where one participant appeared to have a reading profile similar to an individual with a reading disability: characterized by low scores on all phonological processing, oral language, decoding, and measures of reading comprehension. Collectively, research suggests that children with ASD may demonstrate impairments in a wide range of reading skills when compared with age-matched peers, and a small portion of these children may experience difficulty learning to read due to impairments in phonological processing.

Comprehension and Phonological Processing.

Several researchers report marked differences between decoding skill and comprehension skill among readers with ASD. Huemer and Mann (2012), for example, examined the difference among 384 children with Autism, Asperger's, and Pervasive Developmental Disorder-Not Otherwise Specified (PDD-NOS) with an average age range between 10 and 11 years old. Results demonstrated that all three groups scored above the population mean on measures of decoding, however children with Autism and PDD-NOS scored below population means on measures of comprehension (while those with Asperger's scored above population means on measures of comprehension). Asberg, Dahlgren, and Dahlgren Sandberg (2008) have also reported poor comprehension skills among readers with ASD in comparison to children with deficits in attention, motor control, and perception (DAMP), TD peers with and without dyslexia. Collectively, research demonstrates that many children with ASD have comprehension difficulties (Asberg et al., 2008; Grigorenko et al., 2003; Huemer & Mann, 2010; Jacobs & Richdale, 2013; Nation et al., 2006; Newman et al., 2007; O'Connor & Klein, 2004).

Some researchers suggest that comprehension difficulties may be related to social difficulties often experienced by children with ASD. Jacobs and Richdale (2013) for example, discussed that some children with ASD demonstrate better reading comprehension when reading

factual (e.g. non-fiction) versus non-factual (e.g. fiction) based books. This suggests that due to social difficulties, children with ASD may not connect with or read as well non-factual books. Researchers have also demonstrated that phonological processing and decoding may have a strong effect on reading comprehension. Asberg, Dahlgren, and Dahlgren-Sandberg (2008), for example, demonstrated a strong relationship between word decoding fluency and sentence reading comprehension for both individuals with ASD and DAMP. This indicates that poor word reading and decoding scores are likely tied with poor reading comprehension. Jacobs and Richdale (2013) confirmed this relationship, where they found decoding was the strongest predictor of reading comprehension for children with High-Functioning ASD (HFASD).

The literature collectively suggests that comprehension difficulties experienced by individuals with ASD may be a direct reflection of poor word decoding problems or poor phonological processing skills (Asberg et al., 2008; Huemer & Mann, 2010; O'Connor & Klein, 2004; Whalon & Hart, 2011). Research also indicates that children with ASD who have stronger phonological processing skills are able to use that ability in reading comprehension. Together this indicates that future research should examine the phonological skills among individuals with ASD in relation to reading success, and use this knowledge to effectively teach children with ASD to learn to read.

Phonological Awareness.

As previously discussed, phonological awareness (PA) is a skill that develops parallel to and often facilitates reading development. This phonological processing skill may be responsible for poor word decoding, phonological skills, or comprehension skills. Only recently, researchers have begun to examine the relationship between phonological awareness skills and reading skills for children on the Autism Spectrum.

Researchers Hooper, Poon, Marcus, and Fine (2006) examined the neuropsychological characteristics of 23 children aged 5 to 12 years old. They reported that children with ASD were

statistically different on 8 of 14 tests in comparison to a TD comparison group matched for age, race, gender, and parent education. Specifically, significant group differences revealed statistically weaker phonological processing skills among children with ASD than TD control group (Hooper, Poon, Marcus & Fine, 2006). Similar results reported by White et al. (2006) found that like children with dyslexia, poor readers with ASD demonstrated severe deficits in phonological processing in comparison to TD peers, with the exception of Rapid Automatic Naming (RAN) scores. Findings by White et al. (2006) also demonstrated the important role that phonological processing plays in reading development: measures of PA and RAN (phonology composite) were found to be strongly correlated with reading ability for all groups with ASD and dyslexia in their sample. Specifically, the phonology composite (PA and RAN) alone accounted for 52% of the variance in literacy performance, with no other factors as significant predictors of reading scores (White et al., 2006). This research suggests that phonological processing skills, specifically PA, may have powerful implications for the reading acquisition of students with ASD or dyslexia.

More recently, researchers have examined reading proficiency and individual differences in word reading among readers with ASD. In an effort to provide explanations for reading difficulties experienced by children with ASD, specific attention has been given to phonological awareness. Newman et al. (2007) found children with ASD without hyperlexia and children with ASD and hyperlexia performed more poorly on measures of PA than TD children. Huemer and Mann (2010) found similar results within their sample, where children with Autism and PDD-NOS fared the worst on measures of PA in comparison to children with Asperger's and TD children with dyslexia. Both Newman et al. (2007) and Huemer and Mann's (2010) research indicates that children with ASD, regardless if having hyperlexic tendencies, demonstrate poor PA skills compared to TD peers. Smith Gabig (2010) replicated these results, reporting that 5 to 7 year old children with ASD in her sample demonstrated average sight word identification

scores, but scored below average on measures of PA (blending and elision), in comparison to age-matched TD peers. Together, these findings indicate that children with ASD are vulnerable or likely to score poorly on measures of phonological awareness, which may hinder reading development.

Other researchers have demonstrated that a specific subset of phonological awareness may account for some of the difficulty experienced by poor readers. Asberg and Dahlgren Sandberg (2012), for example, reported that 33% of their sample of 10 to 15 year old children with ASD were poor word readers, which was often accompanied by poor scores in phonemic awareness. In comparison to TD age matched peers, poor word readers with an ASD performed worse on measures of phonemic awareness, indicating that PA deficits specifically in phonemic awareness may be related to difficulty experienced by poor readers with ASD (Asberg & Dahlgren Sandberg, 2012).

Within the literature on children with ASD, there is considerable evidence that the level of variance in reading ability for individuals with ASD is quite heterogeneous rather than homogeneous (Nation et al., 2006; Whalon & Hart, 2011). This evokes the need to understand and scaffold reading instruction to the individual needs of each child based on specific areas of strength and weakness. As children progress through schooling, adequate and robust word reading and comprehension depend on a strong foundation of reading and analysis skills, including phonological processing. As reported within the literature, children with ASD identified as being poor or proficient readers with or without hyperlexia, demonstrate weaker phonological awareness skills in comparison to their TD aged matched peers. These deficits in phonological processing, specifically in phonological awareness, may be significant contributing factors to poor reading skills among children with ASD. This holds powerful implications for the assessment of and inclusion of PA skills in reading interventions for children with ASD (Asberg & Dahlgren Sandberg, 2012).

Committing to Effective Education for Children with Diverse Learning Needs and ASD

The government of Ontario committed to a large-scale model of change for Ontario's education system in 2003 which adopted several initiatives to support education programs, practices, and training for children and youth with special needs and ASD and those working with them. These initiatives aimed to transform special education programs to foster the achievement and development of educational skills for all students.

In 2005, Ontario's Ministry of Education (2005) published a report which informed and reinforced effective teaching practices in reading, writing, oral communication and math. This report condoned the use of an effective, tiered approach toward early identification and intervention strategies for children with special needs and provided educators with a specific review of effective teaching strategies for students receiving special education services within the province of Ontario.

In 2007, the government of Ontario published two more reports as educational standards for best practices in addressing the diverse educational needs of children and youth with ASD (Ontario Ministry of Education & Ontario Ministry of Children and Youth Services, 2007; Ontario Ministry of Education, 2007). These reports envisioned that students with ASD, "achieve their potential with respect to learning through effective evidence-based educational practices and responsive, child and youth centre programs and services to enhance lifelong learning within a quality of life framework" (Ontario Ministry of Education & Ontario Ministry of Children and Youth Services, 2007, p. 8). Both reports argue that effective education for students with ASD requires addressing the unique individual, social, emotional, physical, and learning needs of each student with ASD, and committing to sensitive, timely, responsive, and positive performance-based practices.

Ontario's Ministry of Education and Ministry of Child and Youth Services remains dedicated to improving the literacy education of students receiving special education services,

and those with ASD. As demonstrated in the literature, evidence based instructional techniques focusing on the basic skills of reading such as decoding and phonological awareness are supported by Ontario's Ministry of Education (2005). Parallel with the literature, Ontario educators are to individualize assessments, instruction, and carefully monitor the progress of each child to ensure that the needs of each individual child are met. Moreover, reading instruction for students with ASD within Ontario schools should ensure that students have the ability to master skills before moving on to more complex skills, and should include direct instruction that is explicit, systematic, and comprehensive with sufficient intensity and duration (Ontario Ministry of Education, 2005). Overall, the Ontario government has adopted their best practices to ensure that the educational needs of all students receiving special education services, including students with ASD, will achieve their full potential within the education system. Similar practices should be adopted by all other agencies supporting the educational development of children with ASD within the community.

Effective Reading Interventions for Children with Diverse Learning Needs.

Children with diverse learning needs, including children with RDs, LDs, IDDs, hearing or communication difficulties may need support in different ways that typically developing children when learning a new skill such as reading. The duration and intensity of effective reading interventions however varies within the literature. Ontario's Ministry of Education (2005) suggests that students receiving special education services may need more intense contact with reading instruction than that provided to other students. Schuele and Boudreau (2008) specifically suggest that 15 to 30 minute interventions implemented 3 to 5 times per week for a total of 7 to 12 weeks, are effective in improving literacy and PA scores. For children with DD or behavioural concerns, Phillips, Clancy-Menchetti, and Lonigan (2008) suggest that more explicit instructions and one-on-one learning environments may be more successful when using PA instruction. Overall, few researchers have examined the most effective duration and intensity

of reading interventions for high risk readers with various learning needs; however, the literature appears to indicate that effective reading instruction should be provided several times a week for a short duration with high intensity or one-on-one support from an educator.

The most important component of an effective reading intervention however, is the type of instructional technique and the content taught. Researchers have recommended that teachers and practitioners design reading interventions for children with diverse learning needs around five specific core literacy components suggested by the National Reading Panel: 1) phonemic awareness, 2) phonics, 3) reading vocabulary, 4) reading fluency, and 5) reading comprehension (Grindle et al., 2013; National Institute of Child Health and Human Development, 2000; Regents of the University of Minnesota, 2011). How effectively these skills are taught to students however, may depend on each individual student's progress. Ontario's Ministry of Education (2005) for example, suggests using techniques such as guided practice, modeling, and explicit individualized feedback to students to aid in reading instruction.

Researchers have also discussed the importance of targeting phonological processing skills, specifically phonological awareness, to help students with diverse needs learn how to read. Torgesen et al. (1999) for example, found that 20 minute lessons including explicit phonological awareness instruction, four times a week for 2 and a half years was the most effective reading intervention in improving word level reading skills for children with reading difficulties. These results suggest that instruction consisting of 80% word level and 20% text level activities is more effective in improving word reading for children with reading disabilities, compared to instruction comprised of 43% word level and 57% text level activities. Furthermore, Torgesen and colleagues (1999) concluded that one-to-one instruction is most effective when it includes explicit and intensive instruction of PA skills like phonemic awareness and phonetic decoding.

Ultimately, the success of an intervention depends on careful scaffolding of instruction based on the student's pre-existing skills, and the inclusion of the five core literacy components

suggested by the National Reading Panel (Grindle et al., 2013; National Institute of Child Health and Human Development, 2000; Regents of the University of Minnesota, 2011; Schuele & Boudreau, 2008). In doing so, teachers and practitioners can strengthen a child's ability to acquire reading skills by using the most effective teaching tools and engaging students in literacy instruction.

Effective Literacy Programs for Children with ASD.

Effective reading interventions for children with ASD value several components that parallel those included in effective reading interventions for students experiencing difficulty learning to read. Researchers have found that both systematic exposure to code-focused and meaning based comprehension instruction may be beneficial for students with ASD (Whalon, Al Otaiba, & Delano, 2009; Whalon & Hart, 2011). Emphasis on teaching both these fundamental skills to children will help them progress from learning to read, to reading to learn, as expected by school curricula (Whalon & Hart, 2011). Since the reading patterns of children with ASD are varied, it is important to construct a strong skill base and a general understanding of language in order to be a successful reader; this can be done by placing emphasis on code-focused programs and teaching phonological awareness and phonological decoding (Ministry of Education, 2005; Whalon et al., 2009).

As reported within the literature, children with ASD identified as poor or proficient readers with or without hyperlexia, demonstrate weaker phonological awareness skills in comparison to their TD aged matched peers. These deficits in phonological processing, specifically in phonological awareness, may be a significant contributing factor to poor reading skills among children with ASD (Asberg & Dahlgren Sandberg, 2012). Effective reading programs for students with ASD experiencing difficulty should parallel effective literacy programs for children with LD or RD, by targeting each of the five specific core literacy components: 1) phonemic awareness, 2) phonics, 3) reading vocabulary, 4) reading fluency, and

5) reading comprehension, with a specific interest in explicit phonological awareness instruction (Grindle et al., 2013; National Institute of Child Health and Human Development, 2000; Regents of the University of Minnesota, 2011; Torgesen et al., 1999).

Other researchers suggest that effective reading programs should include sight word and systematic comprehension instruction, and focus on letter knowledge, oral reading fluency, and vocabulary in addition to phonological processing skills such as phonological awareness (Asberg & Dahlgren Sandberg, 2012; Hooper et al., 2006; Huemer & Mann, 2010; Mirenda, 2003; Nation et al., 2006; Newman et al., 2003; Smith Gabig, 2010; Whalon et al., 2009; Whalon & Hart, 2011).

The effectiveness of a reading intervention is also dependent on the method of instruction. Within the literature, researchers have found a variety of methods of instruction that are effective in teaching a variety of academic, social, and life skills to children with ASD. Discrete trial teaching (DTT) is a common method for instruction for children with ASD. This consists of three main components, "(i) an instruction from teacher; (ii) a response by the learner; (iii) a consequence (e.g., positive reinforcement or corrective feedback) provided by the teacher following the learner's response" (Leaf et al., 2013, p. 82). This method has been used to teach a variety of skills such as receptive and expressive labelling, conversation skills and self-help skills. Leaf et al. (2013) compared the effectiveness of one-to-one DTT with group instruction DTT in teaching children with ASD a variety of targeted skills. They found both instructional formats were effective in teaching targeted skills: the group format provided the opportunity for observational learning to occur, while the one-to-one format provided focused individualized learning (Leaf et al., 2013). Kamps, Walker, Locke, and Delquadri (1990) however found that, when feasible, one-to-one formats of instruction were more effective than small group instruction for children with ASD. The one-to-one format may enable teachers to provide individualized feedback, explicit instruction, and allow teachers to more carefully monitor

progress and scaffold instruction (Ontario Ministry of Education, 2005). In comparison to small or whole classroom lessons, Whalon, et al. (2009) concluded that one-to-one computer-based programs may be more effective in improving phonological awareness scores of children with ASD. While group and individual formats of instruction have distinct advantages, more researchers appear to advocate for one-to-one instructional formats. This instructional format is ideal to teach students with ASD to learn printed words, specifically when using a quick massed trial approach with systematic visual and verbal prompting, and differential reinforcement (Kamps et al., 1990; Spector, 2011; Whalon et al., 2009).

Several researchers appear to focus less on the format of reading instruction for children with ASD, and place more emphasis on specific techniques to teach these skills (Whalon et al., 2009). For example, Whalon and Hart (2011) suggest that some children with ASD may require extra support regarding the social aspects of reading and language instruction. Simple verbal support during reading instruction in the form of conversations or teacher directed question methods, for example, may not always be useful for children with ASD when learning to read (Whalon & Hart, 2011). Rather, researchers suggest that concrete supports such as visual prompts, established routines, modeling and nonverbal cues, guided and individual practice with specific and immediate positive feedback, may be more effective in assisting a child's reading development (Ontario Ministry of Education, 2005; Phillips et al., 2008; The Regents of the University of Michigan, 2013; Whalon et al., 2009; Whalon & Hart, 2011).

Together, research demonstrates that reading programs designed for students with ASD should directly target phonological processing, decoding, and comprehension. Teaching these skills in a direct and explicit manner through planned instructional sequencing with modeling, practice, feedback and review, can help to best support a child's literacy development (Asberg & Dahlgren Sandberg, 2012; Huemer & Mann, 2010; Hooper et al., 2006; Mirenda, 2003; Nation et al., 2006; Newman et al., 2003; Phillips et al., 2008; Smith Gabig, 2010; The Regents of the

University of Michigan, 2013; Whalon et al., 2009; Whalon & Hart, 2011). Despite limited research on the effects of PA specific instruction for children with ASD, research on other students with poor phonological processing skills provides a framework for effective reading instruction. Scaffolding literacy programs to suit the PA level and learning style of students by incorporating a variety of teaching methods can help teachers to improve PA and other reading skills of students with ASD.

Importance of Student Enjoyment and Engagement.

Fostering a favourable learning environment has also contributed to improved student outcomes. Researchers have demonstrated that interest and engagement in reading activities are likely to lead to more opportunities to learn and practice reading (Baroody & Diamond, 2014). In an examination of 167 four to five year old TD children, Baroody and Diamond (2014) found positive correlations between teacher-reported child interest, large group classroom engagement, and measures of phonological awareness, letter-word identification, and expressive vocabulary. These results indicate that student interest in reading activities promoted engagement in the activities, which had a positive effect on reading skills. Similar results reported by De Naeghle, Van Keer, Vansteenskiste, and Posseel (2012), found a positive relationship among reading engagement, enjoyment, and reading outcomes for 1260 TD grade five students. De Naeghle and colleagues (2012) specifically found that students who enjoy reading, spend more time reading for leisure, are more engaged in reading, and perform better on standardized comprehension assessments than those who do not. Similar results reported by Jones and Brown (2011) found that enjoyment of the text was well reflected within comprehension scores of 22 grade 3 students using e-books versus traditional print books. Specifically, when students were interested in a story, they enjoyed the reading activity more and scored higher on measures of reading comprehension than when interest and enjoyment were low (Jones & Brown, 2011). These results provide evidence that enjoyment of texts or reading activities is a key factor in

keeping students in preschool to high school engaged, which is also associated with positive early reading skill and comprehension outcomes.

Student engagement in typically developing children has also been associated with positive learning outcomes. In a 8 year longitudinal study, Ladd and Dinella (2009) examined the relationship between behavioural engagement and scholastic growth. They found that students with high engagement in grades 1 to 3 was predictive of long term growth on measures of reading and math in grade 8, where those with higher engagement demonstrated better academic achievement than those with lower engagement (Ladd & Dinella, 2009). Guthrie, Klauda, and Ho (2013) found similar results for 1 159 seventh grade students (9% qualified for special education) during language arts instruction. Students with higher engagement (increased engagement and reduced avoidance behaviour) toward reading were directly associated with greater achievement on measures of reading comprehension and text fluency. In line with other researchers in the field, Ladd and Dinella (2009) and Guthrie, et al. (2013) have demonstrated the importance of engaging students during academic instruction. Through improving student engagement during reading instruction, for example, the reading performance and academic achievement outcomes of students in elementary and high school will increase (Guthrie, Wigfield, & You, 2012).

Research on engagement and educational outcomes, such as reading, also have important implications for students on the Autism Spectrum. Several researchers have discussed the utility of specific strategies such as visual cues, planned activity routines, activity schedules, and multiple forms of teacher direction in assisting students with ASD attend to and engage with academic material (Hart & Whalon, 2008), yet few have studied the direct effects. Carnahan, Basham, and Musti-Rao (2009) found that interactive books with and without music increased small group engagement for 5 children with Autism between the ages of 6 and 11 years old. Across all participants, percent of active engagement was 20% higher when interactive books

were accompanied with musical narration. These results indicate that adding musical components to reading activities can significantly increase the active engagement of students with ASD (Carnahan, Basham, & Musti-Rao, 2009).

Overall, research suggests that children who enjoy and participate in literacy activities, "are more likely to do better on assessments of letter-word identification, expressive language, and phonological awareness" (Baroody and Diamond, 2013, p. 13). Preliminary research among children with ASD suggests that specific strategies can significantly increase the active engagement of students with ASD. Future research is needed to examine the effects of students with ASD's enjoyment and engagement with reading instruction on reading skills. In general, future research should examine effective reading activities and instruction for children with ASD which incorporate student interests, in turn making reading an enjoyable and engaging activity, and potentially aid in reading acquisition.

***Using Technology to assist in Learning*.**

Several researchers have argued for the use of alternative formats of instruction for children with ASD to help capture student engagement and make learning enjoyable. Some reading programs designed for children with ASD have included computer activities with speech output systems to develop these skills. When used appropriately, computer assisted instruction is a valuable method of teaching academic skills to students with ASD. Examples of such computer assisted instruction (CAI) programs are HeadSprout Early Reading©, Microsoft PowerPoint©, Alpha Interactive Language Series©, and Delta© (Whalon et al., 2009; Yaw et al., 2011).

Several researchers have suggested that electronic screen media is another form of technology that can be incorporated to increase the engagement of students with ASD during instruction. Mineo, Ziegler, Gill, and Salkin (2009), for example, argued that electronic screen media is visually interesting and enables those with ASD to focus and divert their attention to

specific relevant stimuli. If students with ASD are engaged and able to maintain attention with the instructional electronic screen media, then screen based technology holds considerable promise as an instructional tool for individuals with ASD. As such, Mineo and colleagues (2009) studied 42 students with ASD between the ages of 6 and 18 years old to examine participant engagement with electronic screen media. They found that all participants were highly interested and engaged in three electronic screen media types (self-virtual reality, other virtual reality, and self-video), and engagement was increased when a change in the audio or video occurred. Carnahan, Basham, and Musti-Rao (2009) found similar results by using interactive books with music for 6 children with Autism between the ages of 6 and 11 years old. Average levels of percent engagement reached 81% compared to 41% at baseline when using interactive books with musical narration. Together, these results indicate that simple technology such as interactive books with musical narration, and more advanced technology such as electronic screen media, have significant potential to capture the engagement of students with ASD and potentially to provide the opportunity for positive learning outcomes.

Other forms of computer-assisted instruction have demonstrated promising results on the reading outcomes of children with ASD. Heimann, Nelson, Tjus, and Gillberg (1995), for example, examined 11 children aged 6 to 13 years old with ASD who used an interactive computer program named Alpha Interactive Language Series© as a supplementary tool to regular classroom instruction. They found that significant gains in phonological awareness and word reading were demonstrated in children with ASD in comparison to typically developing peers, who made reading gains regardless of the type of instruction provided, and children with ASD seemed to best benefit from computer-assisted instruction (Heimann, Nelson, Tjus & Gillberg, 1995). Whalon et al. (2009) reported similar results, where phonological awareness scores of participants improved by including one-to-one computer-assisted components within regular literacy instruction. Delta*Messages*, another multimedia computer program, aims to

foster reading and language development through computer-assisted sentence construction (Tjus, Heimann, & Nelson, 2004). When used with teacher support, Delta*Messages* was found to significantly increase the reading scores of a sample of 13 children with Autism aged 4 to 11 years old (Tjus, et al., 2004). Despite not reporting specific reading skill gains and demonstrating lack of skill maintenance one and a half months later, Tjus and colleagues (2004) hypothesized that the program was successful with this group because the program provided immediate feedback and enabled students to repeat activities. Overall, several computer-based reading programs demonstrate gains in overall reading ability, and phonological awareness, for children with ASD.

Although some researchers have not demonstrated significant differences in reading outcomes when using technology compared to more traditional reading materials, Jones and Brown (2011) argue there are several advantages to incorporating technology within reading activities: the interactive features of e-books such as read aloud text, vocabulary words pronounced for students, and sound effects appear to be uniquely interesting for students. Williams, Wright, Callaghan, and Coughlan (2002) suggested that CAI may be more engaging and interesting for students with ASD in comparison to using traditional book methods. Other researchers have also suggested that CAI methods may also help reduce social barriers to learning, and increase language and communication skills (Heimann et al., 1995; Mineo, Ziegler, Gill & Salkin, 2009; Mirenda, 2003; Pennington, 2010; Whalon et al., 2009). Teachers and researchers should also carefully consider how technology is used as an instructional tool: research suggests that computer based programs may be most effective when integrated with regular classroom instruction, and may have better learning outcomes when children use computer-based programs with adult or teacher accompaniment (Heimann et al., 1995). Overall, research conducted with TD students and students with ASD suggests that when used appropriately, computer-assisted instruction and other forms of technology may aid in reading

instruction. Future research needs to specifically examine enjoyment and engagement of students with ASD with CAI and other technology-based reading instruction programs, and examine if engaging and enjoyable CAI reading programs contribute to positive reading outcomes.

HeadSprout Early Reading.

HeadSprout Early Reading (HeadSprout) is an example of such a CAI program that has empirically proven to support the literacy development of at risk readers. HeadSprout Early Reading (HeadSprout), is an internet-based computer reading program that focuses on phonics, phonemic awareness, vocabulary, comprehension and oral fluency instruction (HeadSprout Early Reading, 2012; Appendix A). Through a total of 80 cartoon-based episodes, children learn reading skills through interactions with characters in different environments such as space, under the sea, in the jungle and with dinosaurs (Layng, Twyman, & Stikeleather, 2004). HeadSprout establishes routines for vocal pronunciation, blending and segmenting, sentences and stories, fluency, motivation and applications that provide students with sufficient opportunities to practice (Headspout, 2008). An advantage of HeadSprout instruction may also be the on-going adaptation of instruction based on the, "frequency and ratio of correct and error responses for each child, rate of responding, or specific error patterns, to offer the most beneficial lesson for that particular learner" (Grindle et al., 2013, p. 205).

In addition to the engaging and adaptive nature of the program, HeadSprout has also been demonstrated to improve early reading skills for a variety of participants. Layng et al. (2004), for example, found that 90% of typically developing children demonstrated a substantial improvement in their ability to read words from pre to post-test. Similarly, Huffstetter, King, Onwuegbuzie, Schneider, and Powell-Smith (2010) implemented HeadSprout for 62 at risk preschool children for 30 minutes a day over a course of 8 weeks. Results indicated that in comparison to a control group, children using HeadSprout made greater gains in early reading

skills and oral language, moving from one standard deviation below average, to approximately average performance post program completion (Huffstetter, King, Onwuegbuzie, Schneider, & Powell-Smith, 2010). More recently, Twyman, Layng, and Layng (2011) randomly assigned 125 kindergarten and first grade students to a 40-minute HeadSprout or a control math program condition and compared the groups on measures of letter-word identification, word reading, reading comprehension, and word analysis. After completion of at least 41 HeadSprout lessons within a school computer lab, results indicated that participants demonstrated positive increases on reading measures in comparison to the control group (Twyman, Layng, & Layng, 2011). Together, these findings provide empirical evidence of the utility of HeadSprout in improving early reading skills of at risk or typically developing children.

HeadSprout has been just begun to be evaluated with children with ASD. Whitcomb, Bass and Luiselli (2011) for example, evaluated HeadSprout Early Learning for a 9 year old student with Autism on measures of word reading accuracy in isolation and in short stories. After completing 23 HeadSprout sessions in a multiple baseline design across word sets and readers design, the participant improved on reading word sets and text within readers (Whitcomb, Bass & Luiselli, 2011). Similarly, Grindle et al. (2013) examined fluency measures of initial sound, phonemic segmentation, word use, nonword and letter naming, and word recognition skills for 4 children with ASD between the ages of 4 and 6. Researchers reported that after completing HeadSprout lessons 3 times a week with supplemental discrete trial teaching for a total of 40 lessons, participants demonstrated early reading skills consistent with those of typically developing learners (Grindle et al., 2013). Skill maintenance was also reported by Grindle et al. (2013), where reading skill gains were maintained 8 weeks after the completion of the intervention program. In addition to improving a variety of reading skills for children with ASD, researchers have spoken to the benefits of the HeadSprout program in designing and planning for generalization of word reading across different reading sets (Whitcomb et al., 2011).

HeadSprout Early Reading may hold considerable promise to help develop a variety of early reading skills for students with ASD, with added benefits of skill possible generalization and maintenance. Researchers have also reported additional benefits of this instructional tool as students showed interest and excitement about the HeadSprout program (Huffstetter, King, Onwuegbuzie, Schneider, & Powell-Smith, 2010). As a result, researchers may conclude that HeadSprout Early reading may be an effective, easy to implement reading program that provides unique enjoyable and engaging learning opportunities for children with ASD. Furthermore, the scope of reading skills covered within this program makes it a useful tool for parents, teachers, and therapists alike. To date, no research has examined participant enjoyment and engagement with the HeadSprout program, in addition to examining the program's effectiveness in improving the phonological awareness skills. The present study aims to fill this gap in the literature by evaluating both the effectiveness of HeadSprout Early Reading in improving the phonological awareness skills of a participant and qualitatively describing participant enjoyment and engagement with the program.

Chapter 3

Methods

Research Design

The research design used for this project was a mixed method design with pre-, mid-, and post-tests to measure gains in phonological awareness of a child with Autism Spectrum Disorder and ADHD attending a reading project using HeadSprout Early Reading. Other research designs were not appropriate due to the nature of the variables being measured. For example, a reversal design was not appropriate since phonological awareness is a developing and acquired skill that is not reversible. The multiple probe design has limitations in that the design does not enable verification or replication of the effect of the HeadSprout program on phonological awareness scores (Cooper, et al., 2007). The mixed method multiple probe design did, however, enable the researcher to probe phonological awareness scores prior to receiving reading intervention, at the mid-point of the reading intervention, and immediately following the completion of the reading intervention program (Cooper, et al., 2007). This design permitted an assessment of the relationship between exposure to the independent variable (HeadSprout Early Reading) and the dependent variable (phonological awareness).

This design also provided a useful framework to collect, analyse, and integrate additional qualitative and quantitative measures to describe the participant's engagement and enjoyment of the HeadSprout Early Reading program. Together, both quantitative and qualitative methods provided unique information to draw conclusions about the effectiveness of HeadSprout in developing PA skills of a child with ASD, and describe how the program was experienced by the participant.

The following figure summarizes how the research design addressed each dependent variable:

Research Question	Target Variable	Measurement Method	Method of Analysis
1. Does HeadSprout Early Reading significantly improve the phonological awareness score of a child with ASD?	Phonological Awareness	**Quantitative**: Comprehensive Test Of Phonological Processing (CTOPP), specifically focusing on PA and Alternative PA Composites	Clinical gains
2. How does the child engage with HeadSprout Early Reading?	Engagement	**Quantitative**: Momentary Time Sampling of engagement (eyes on screen) Perceived Engagement Rating (observations) **Qualitative**: Researcher Observations + Reflective Research Journal	Total percent engagement versus total percent off-task (graph) Report as Average Rating + Average Daily Total (graph) Report main themes and trends
3. Is HeadSprout Early Reading an enjoyable reading activity for a child with ASD	Enjoyment	**Quantitative**: Participant Self-Report rating scales Perceived Enjoyment Rating (observations) **Qualitative**: Researcher Observations + Reflective Research Journal	Report as Average Rating (graph) Report as Average Rating + Average Daily Total (graph) Report main themes and trends

Participant Recruitment.

Participant recruitment began on September 1st, 2013 after receiving ethical clearance from Brock University's Social Science Ethics Review Board. Potential participants were recruited through advertisements and letters of invitation directed to parents. Participants were recruited through advertisements on the Autism Ontario Niagara Chapter's website, and through clinical directors of Autism support agencies in the Niagara Region. Examples of the recruitment poster and letter of invitation are attached in Appendix B and Appendix C. Upon

response to advertisements by telephone or email, parents were contacted and invited to learn more about the research project and invited to an assessment meeting date in December 2013.

Eligibility.

To be eligible to participate in this research project, at the time of assessment the individual must: a) have a chronological age between 4 and 8 years old, b) have a formal diagnosis of Autism Spectrum Disorder based on DSM-criteria, c) have a functional verbal ability at the sentence or phrase level, d) have significant impairment with phonological awareness (scores below the 20th percentile on the Phonological Awareness Composite of the Comprehensive Test Of Phonological Processing; CTOPP; Wagner, Torgesen, & Rashotte, 1999), e) not have hyperlexic tendencies (i.e. scoring high in decoding, but low in comprehension), and f) not have auditory processing difficulties. All potential participants were to be located within the Niagara-Hamilton Region.

Participants were ineligible to participate in the research program if their scores were above the 20th percentile on measures of PA on the CTOPP, they demonstrated difficulty with auditory discrimination, or were diagnosed with a disability other than Autism Spectrum Disorder.

Assessment Meeting.

One hour assessment meetings were conducted with four potential participants in January 2014. Assessment meetings took place at a research meeting office at Brock University, and were scheduled at a time most convenient to the potential participants and their families. The primary purpose of the assessment meeting was to screen potential participants based on the eligibility requirements.

During this meeting, the primary researcher reviewed the letter of invitation with parents and potential participants, described the consent form for assessment (Appendix D), and provided parents and potential participants with the opportunity to ask any questions. Parents

were asked to sign the consent form, and potential participants were asked to assent to participating in the assessment process. Upon receiving consent from both parties, parents were asked to wait in a separate room while the primary researcher completed the eligibility assessment.

Eligibility assessments included examining functional verbal ability, screening for hyperlexic tendencies, screening for auditory processing difficulties using the Wepman Auditory Discrimination Test (Wepman, 1986) and testing phonological awareness ability using the Comprehensive Test of Phonological Processing (Wagner, Torgensen, & Rashotte, 1999). Participants who met these inclusion criteria were invited by email to participate in the research program. Parents of participants who did not meet eligibility requirements were informed by email and provided with other reading resources for children with ASD.

One participant met all eligibility criteria. The parents of the participant who qualified were emailed a letter of invitation stating that their child qualified to participate in the research study (Appendix E) and a program consent form which reviewed the details of the study, what participation entailed, that consent is an on-going process and should they wish to be removed from the research study at any time without penalty they could do so by contacting the primary investigators (Appendix F). Parents were also asked to complete a pre-program preference questionnaire which aimed to obtain information regarding potential reinforcing activities, toys, and snacks that could be useful during program implementation (Appendix G).

Consent.

Parental consent and participant assent was collected at two time periods: a) prior to collecting any information in the assessment meeting, and b) prior to beginning the research program. At the beginning of the assessment meeting, the primary researcher explained the details of the study and the consent process to potential participants and their parents. Parents and potential participants were encouraged to clarify or ask to any questions about assessment,

research participation and the research project. Parents were asked to sign the consent form to give permission to collect data to assess participant eligibility (Appendix D). Verbal assent was requested for the potential participant's participation in the assessment meeting. Parents were encouraged to keep a copy of the signed consent forms.

Parental consent and child assent for program participant were collected on the first day of programming using the Program Consent Form located in Appendix F. The participant was informed of his rights and his parents' right to withdraw from the research project at any time, should they wish to do so without consequences or penalties. If the participant chose to withdraw from a program session (i.e. wished to discontinue mid-session), the data collected on that particular day would be kept, and the programming would resume the next consecutive session. The participant was also informed that if he missed more than 7 sessions (attendance less than 75%), he would be removed from the program.

Child Assent.

Potential participants were required to provide verbal assent to the researcher prior to participating in the assessment interview and the research program. The assent process included a verbal description of the research project for potential participants detailing the risks and benefits of participating, protections provided for confidentiality, the nature of voluntary participation, and the method of distribution of the results. To ensure that the potential participants understood that their participation was voluntary, they were asked a few comprehension questions prior to signing the consent form as illustrated in Appendices D and F. If participant(s) had experienced difficulty answering these questions, the investigator would have rephrased and described the research study the questions in simpler language until the participant understood; this however was not applicable. When the child demonstrated his understanding of the research project, voluntary participation, and on-going consent, the child provided verbal consent to participate and his parent wrote his name on the consent form.

Assent was collected a second time, prior to participating in the research program.

Participant

One participant met all eligibility criteria and agreed to participate in the study. A second wave of recruitment efforts in February and March 2014 did not produce any interest in program participation.

At the time of recruitment, Kyle (pseudonym) was 7 years old and had received a diagnosis of ASD according to DSM-IV criteria, Attention Deficit Hyperactivity Disorder (ADHD), and Oppositional Defiant Disorder (ODD). Kyle scored at the 16th percentile on the Phonological Awareness Composite of the CTOPP, and the 12th percentile on of the Alternative Phonological Awareness Composite of the CTOPP. Kyle had no known hyperlexic tendencies, had a functional verbal ability at the sentence or phrase level, and scored within the acceptable range on the Wepman Auditory Discrimination Test indicating he had no auditory processing difficulties.

Kyle's parents completed the pre-program preference profile (Appendix G) which revealed that Kyle liked to use the computer to play games and search his favourite topics, watch movies and shows, play pretend with his sibling, and play outside. Kyle's parents also indicated that he is musically inclined, has a strong memory, and is good at navigating the computer, however activities that require fine-motor ability and reading are difficult for Kyle.

Reading Intervention Program

The HeadSprout based reading intervention program began in April 2014. The program participant, Kyle, attended the program at Brock University three times a week for 9 weeks. The main focus of the program session was 30 minutes of HeadSprout computer programming (covering one or more lessons) which ensured exposure to the program was consistent across sessions. Each program session followed the same general framework and was conducted by the primary researcher.

1. Arrival and Check-In.

At the beginning of each session, the principal student investigator greeted the family and verified consent with the parent(s) and participant. This ensured that consent was ongoing.

2. Warm-Up Activity.

Each program session began with 10 minutes of pairing between the participant and the primary researcher during an activity. This time was intended to assess the student's mood and to create a fun learning atmosphere for the participant prior to beginning the HeadSprout program session. A variety of warm-up activities were completed across all program sessions including taking silly pictures with various filters on the computer webcam, playing with a slinky, blowing bubbles, making paper airplanes, and a picture guessing game on the white board. While the participant appeared to enjoy most warm up activities, he seemed to anticipate starting the program.

3. HeadSprout Computer Programming.

HeadSprout lessons take an average of 10 minutes with an upward limit of 35 minutes (Twyman, Layng, & Layng, 2011), thus 30 minutes was allotted for the participant to use the HeadSprout computer program. Across the 27 program sessions, the participant was exposed to an average of 30 minutes 28 seconds of HeadSprout Early Reading computer programming (range 23 to 37 minutes and 45 seconds). During this time, the participant completed a total of 38 HeadSprout lessons averaging 1.41 HeadSprout episodes (range 1 to 2) per session, and completed an average of 17.18 activities per session (range 10 to 30). Throughout the computer program, the primary researcher prompted and assisted the participant as needed, completed the perceived engagement, enjoyment, and level of assistance required data sheets, in addition to making observations and completing qualitative field notes.

4. Rating of HeadSprout Session.

After completing the HeadSprout lesson, the participant rated his enjoyment of the

HeadSprout computer session. The primary researcher helped the child understand and complete the self-rating activity until he could complete the self-rating independently. Each day, the rating scale rules were reviewed prior to the participant completing their rating of the day's computer session. Following the participant's rating of enjoyment, the primary researcher asked him follow-up questions about what he enjoyed and what he did not enjoy about the day's computer session. The entire rating process took approximately 5 minutes to complete.

5. Book Reading.

The HeadSprout program includes stories, worksheets, and flashcards which coincide with some of the lessons. Researchers Twyman, Layng, and Layng (2011) report that the HeadSprout program is most effective when all 80 lessons and books are completed and read, stating that using the HeadSprout readers is related to positive outcomes. After completing the HeadSprout lesson and star rating, approximately 10 minutes were dedicated to read the HeadSprout stories and complete complimentary HeadSprout student resources. HeadSprout stories provide the reader practice of specific target words learned with the corresponding lessons. For example, when the participant completed Episode 5 the learner read the book, "*See!*", where he practiced reading the words "see", "van", and character names "San", and "Vee" (Learning A-Z, 2014). Corresponding with the 38 lessons completed by the participant, he read a total of 22 Sprout Stories, completed six word-to-picture matching worksheets and four sets of flashcards.

HeadSprout Stories.

HeadSprout Stories were read during the majority of program sessions and included three different types of stories: *HeadSprout Readers* for the child to read independently, *Read with Me Stories* for the child to read with an adult, and *Additional Stories* to practice new and old words. Each story was read at least one time, and often was practiced a second time on another day. This activity was intended to be a reinforcing activity where the researcher scaffolded the

amount of support needed by the child, and provided verbal reinforcement throughout. The primary researcher pointed to the words as they were read aloud and often discussed the story with the participant as he went along. There were often a couple of words that the participant had difficulty with at the beginning of the story, that improved by the end and the second time reading the book. During session 17 for example, the participant mistakenly read the word "feels" as "see", and then "fip" before being prompted to look at the letters and say "feels," by the researcher (book title: "Clee and Pip"). After modeling the correct word, the researcher prompted the participant to read the sentence again; the participant then read the word correctly. During the next session, the participant read all the words in the book "Clee and Pip" correctly.

In general, errorless teaching was used to help minimize errors, whereby the researcher used a least-to-most prompting sequence and modeled the correct word when necessary. As demonstrated in the above example, this was intended to increase reading success, provide repetition of difficult words, and make reading a fun and reinforcing activity.

Flashcards.

Sound and word flashcards were used in approximately half of the program sessions to review with the participant and help practice areas of difficulty. Upon introducing a new flash card set, the participant appeared to experience more difficulty with some words and sounds despite having just completed a lesson with those skill targets. For example, during session 4 the participant was first exposed to flashcard set 1 which included the following sounds and words: v, s, n, ee, an, Vee, San, see, van, the. During the initial reading of the flashcard set 1, the participant erred on the words "vee" and "see". As the participant became more practiced with the sounds and words targeted by the flashcards, the flashcards became easier and fewer mistakes were made; by session 6, the participant was able to read all the sounds and words in flashcard set 1 correctly. Approximately half way through the program sessions, the participant generalized the ability to blend and segment. As he learned in the HeadSprout computer lessons,

the participant began to sound out the words he was unsure about, or did not know by sight, and blended the words together to read the word.

HeadSprout Worksheets.

Six word-to-picture matching worksheets were used to ensure comprehension of specific words and comprehension of their corresponding picture. The participant was asked to read three words on the worksheet and to draw a line to match the word to the corresponding picture. For example, the worksheet that corresponded with lesson 16 had the target words "can", "Fran", and "ran". The participant was asked to read the target words out loud, and match to the corresponding pictures of a pop "can", the HeadSprout character "Fran", and a cartoon character running. Overall, these worksheets were easy for the participant to complete and helped to build his confidence in reading the target words. The participant appeared to enjoy completing these worksheets.

6. Reinforcer Selection.

After completing the complimentary HeadSprout activities, the participant was invited to select an activity, toy, or snack prior to the session wrap-up. For the majority of the sessions the participant selected to have a chocolate chip cookie for his hard work during the program session. The participant often selected a cookie, juice box or water, chocolate, or time to play with the slinky. Despite the participant enjoying the activity, toy, or snack selected, there is not sufficient evidence to demonstrate whether the activity, toy, or snack selected changed or reinforced his rate of participation in the reading program (Cooper, et al., 2007).

During the last session the primary researcher held a pizza party with the participant and his family to celebrate all his hard work. The participant was presented with an achievement award to recognise his achievement with the HeadSprout program and a six paged-coloured HeadSprout map to use in the future with the remainder of the program subscription.

7. Session Wrap-Up and Review with Parents.

At the end of each session, the primary researcher reviewed the session with the participant's parents, highlighted specific skill targets for the day, and the child's progress. This was intended to update his parents about their child's progress across each session. During this time the primary researcher brought up any note-worthy observations or questions with the parents, which enabled discussion to ensure the child was best supported throughout the research program. For example, in one session the participant made intentional errors to hear negative feedback from the computer program. The primary researcher mentioned this to the participant's parents; the participant's parents stated that negative feedback was problematic at school and in the community and was best addressed by preventing or ignoring the feedback. After this discussion the researcher was able to prompt the participant to avoid a similar problematic outcome from occurring again in the future.

Program Completion and Feedback.

The final program session included a post-test CTOPP assessment by the primary researcher and a "party" for the participating child and his family. This pizza party served as a celebration for the child's hard work and a wrap up for program completion. The family was also provided with a general feedback letter thanking them for their participation in the research study and providing them with the appropriate contacts should they wish to contact the investigator for additional feedback or to request the results of the study (Appendix H).

Measures

Eligibility Data.

Potential participants were informed and consented to data collection prior to it being collected. Eligibility was determined through three types of data collection: a) Contact and Basic Information Questionnaire, b) Language assessment, and c) Comprehensive Test of Phonological Processing.

Contact and Basic Information Questionnaire.

The Contact and Basic Information Questionnaire, located in Appendix I, was used to obtain contact and diagnostic information about the child and family. This form was completed by the parents of a potential participant during the initial assessment interview. This measure enabled the researcher to assess for hyperlexia, ASD diagnoses, and rule out other diagnoses.

Language Assessment.

The ability to understand and use language is essential for the HeadSprout program. During the assessment interview, the primary researcher observed the child's verbal interactions during and after other assessments to determine if the child was able to use, "...language beyond single words to perform communicative functions such as requesting, commenting, or greeting" (Smith-Gabig, 2010, p. 72). Language would have been probed if it was not evident prior to completion of the assessment interview. This could have included asking the child to comment on or select a reinforcer for completing the assessment interview. If the child was able to comment or request and was able to respond to the questions during the assessments, then it was ruled that the child had appropriate verbal abilities to participate in this research program.

Adequate auditory discrimination is also essential for using HeadSprout, as the program requires users to understand verbal instructions and rely on their auditory processing and discrimination skills. Wepman (1960) defined auditory discrimination as, "the ability to recognise the different phonemes of spoken language even when the phonetic structures…of the sounds to be discriminated are highly similar in nature" (p. 326). As such, the primary researcher assessed the child's auditory discrimination using the Wepman's Auditory Discrimination Test (Wepman, 1986). The tests involved the researcher presenting the child with a series of 40 word pairs, and asking if the pair were same or different. Inadequate auditory discrimination development was determined if the child made more errors on the 30 different pairs than indicated for their chronological age. The Wepman Auditory Discrimination Test is

reliable with a test-retest reliability coefficient of .91 (Christine & Christine, 1964).

A participant was considered to have suitable auditory discrimination to participate in the research program if the child scored within the acceptable range for their age.

***Comprehensive Test of Phonological Processing*.**

The Comprehensive Test of Phonological Processing (CTOPP) was used to assess participant eligibility in phonological awareness. The CTOPP measures three core components of phonological processing: phonological awareness, phonological memory, rapid naming (Hintze, Ryan, & Stonger, 2003; Wagner, et al., 1999). The test contains a total of 12 subtests, consisting of 18 to 20 items, and takes approximately 30 minutes to complete (Lennon & Slesinski, 2001). Five subtests were completed for the purpose of this study: elision, blending words, blending nonwords, segmenting nonwords, and segmenting words. Each subset produced a score that was converted into a percentile rank and standard score. The CTOPP is a reliable and valid test with reliability coefficients exceeding .80, (Lennon & Slesinski, 2001).

A participant was required to score at or below the 20th percentile on the Phonological Awareness Composite (elision and blending word subtests) of the CTOPP to be eligible to participate.

The CTOPP measure was also used to assess program effectiveness in improving the participant's PA scores. Specifically, the primary researcher completed five subtests of the CTOPP across three time periods: Pre-program (assessment interview), Mid-program (Session 13), and post-program (Session 27).

Daily Program Data Collection.

***Engagement: Momentary Time Sampling*.**

During each program session, the primary researcher video-taped the HeadSprout computer lesson using a webcam. This video was recorded and transferred to a USB storage device and stored in a secure and locked laboratory. Videos were coded after program

completion using a 15 second momentary time sampling procedure to measure participant engagement with the HeadSprout program and off-task behaviour (Cooper, et al., 2007). All 27 program sessions were coded by the primary researcher, and 10 program sessions were coded by an independent second observer to calculate interobserver agreement and establish reliability of the video coding procedures. Please refer to Appendix J for Momentary Time Sampling data sheet and coder instructions.

Coding required the observer to watch, assess, and record the participant's behaviour every 15 seconds for the entirety of the video. To ensure both coders were observing at the same time intervals, both coders were instructed to assess the participant's behaviour at the time indicated on the data sheet; each coding data sheet was tailored to correspond with a specific video. At the time indicated, the observer would look at the child and record if the child was engaged, or involved in off-task: motor, off-task: verbal, or off-task: passive behaviours according to definitions in Appendix J.

Interobserver Agreement.

Interobserver Agreement (IOA) was conducted to ensure accurate, reliable, and valid coding of the Momentary Time Sampling procedure. IOA was calculated using interval-by-interval IOA, using the following formula:

$$\frac{\textit{Number of Intervals Agreed}}{\textit{Number of Intervals agreed + Number of intervals disagreed}} \times 100 = \textit{Interval-by-Interval IOA\%}$$

(Cooper et al., 2007, p. 117).

Prior to calculating IOA, the primary researcher used a sample video-tape to train a second observer to code using the momentary time sampling procedure. Training began by first explaining the empirical definitions of on-task, off-task vocal, off-task motor and off-task passive and providing time for the second observer to ask any questions. The primary researcher

then explained the momentary time sampling data sheet (Appendix J). To ensure the primary researcher and the second observer would meet 80% or higher IOA, training began in a series of phases. Both observers first reviewed two minutes of the sample video together, pausing at each interval and stating what they would score. IOA was calculated and found to have achieved 88% agreement while coding together for two minutes and disagreements were discussed. Next, both observers independently watched and coded two and a half minutes of the video. An IOA of 87.5% was achieved and disagreements were discussed. Both observers then independently watched and coded 10 minutes of the training video. IOA was calculated and found to have achieved 95% agreement, and again disagreements were discussed. The final training phase required observers to obtain 80% or higher IOA while independently watching and coding a full training video. Training was complete when the first and second observer achieved 95.6% IOA for a full training video.

When training was complete, the second observer reviewed and coded 10 randomly selected video-taped program sessions, the equivalent of 37% of all program sessions (Cooper, et al., 2007). A sample IOA coding form is located in Appendix K.

Results indicate that the average interval-by-interval IOA was 90.43% ranging from 85.19% to 96.35%. The high overall percent agreement between the primary researcher and the second observer indicates the results of the momentary time sampling procedure are both accurate and valid (Cooper et al., 2007).

Participant Self-Rating of Enjoyment.

After having completed each HeadSprout lesson, the participant rated his enjoyment of the session's computer lesson using a five-point self-rating scale. The participant was given a file folder with Velcro spots to place up to 5 stars (Appendix L). The participant was taught how to use the rating system and told what each number of stars represented for enjoyment. The participant was then instructed to select the number of stars that best represented his enjoyment

of the session's HeadSprout lesson. This data collection tool was intended to measure the participant's self-reported enjoyment of the computer program and to be used in addition to other measures of enjoyment. After each session was complete, the researcher recorded the student's rating of the HeadSprout lesson on the data sheet located in Appendix M.

Enjoyment Rating Follow-up Questions.

To expand on the participant's rating of his enjoyment of the HeadSprout computer session, the participant was asked by the primary researcher two questions: 1) What did you like best about our work today? And 2) What do you wish you could change about our work together, or is there anything you did not like? If the participant did not respond, or said "all of it," the primary researcher asked the participant to describe why or to give examples of what he liked or did not like about the lesson. Responses were recorded on the Field Notes data collection sheet located in Appendix N.

Perceived Engagement, Enjoyment, and Level of Assistance.

Perceived engagement, enjoyment, and level of assistance required were also assessed during each HeadSprout lesson. Every session, the primary researcher recorded the type of activity within the HeadSprout lesson and rated the level of assistance required, perceived enjoyment and perceived engagement of the participant during each activity. The observer continued this process for each activity, throughout the entire HeadSprout lesson. A detailed description of the operational definitions for each target behaviour, observer instructions, and the data sheet can be located in Appendix O.

After each session, ratings were totaled and averaged across each of the three target variables: engagement, enjoyment, and level of assistance required. A total average rating of engagement, enjoyment, and level of assistance required was calculated for the entire program, and average ratings were calculated across each activity type.

***Qualitative Field Notes*.**

Throughout each program session, the researcher recorded continuous qualitative observations of the participant, with a specific interest in describing the participant's enjoyment, and engagement with the HeadSprout program, and future considerations for program use. Field notes also included descriptions of the type and level of assistance needed by the primary researcher to complete a task, specific areas of difficulty or frustration, in addition to aspects of the program that may have engaged the participant and made it enjoyable for the participant to use. Prior to each program session, the primary researcher reviewed the Field Note Reminder sheet to prompt specific reflections throughout the session (Appendix P). Observation field notes were recorded using the Daily Field Notes data sheet located in Appendix N.

***Qualitative Researcher Reflection Notes*.**

Using a model suggested by O'Connell and Dyment (2013), following each program session the primary researcher reflected on the session. These notes focused reflection on three specific areas: a) Type of instruction used throughout the session (which instruction and types of support worked well, and which did not), b) Now what (application of the instruction and support types to assist the participant in the future), and c) Applications to special education, Applied Behaviour Analysis, and professional practice. Researcher reflection notes were recorded using the Reflective Research Journal data sheet located in Appendix Q. Researcher reflection notes were intended to describe possible implications for the use of computer program for students with ASD and implications to reading and computer assisted instruction for parents, teachers, and other educational professionals.

Data Collection and Storage.

All data were collected and stored in a secure and safe manner. Data collection took place in a private Brock University Lab, and all pre-test, mid-test, post-test, and daily program data were transferred to a secure, locked laboratory by the researcher. Manual data were filed in

a binder and electronic data were stored on an external hard drive within a secure laboratory. All identifying information was removed from the data after program completion. Prior to accessing the 10 videos to be coded, the second IOA observer was required to sign a privacy and confidentiality agreement (Appendix R).

Data Analysis

CTOPP Analysis.

The effectiveness of the HeadSprout program in improving phonological awareness skills consisted of comparing pre-, mid-, and post-test Phonological Awareness Composite (PAC) and Alternative Phonological Awareness Composite (A-PAC) scores of the Comprehensive Test of Phonological Processing (CTOPP). Raw scores and percentile ranks were compared between the PAC and the A-PAC, and across each of the five subtests. Results were represented on a graph to visually demonstrate the changes between the three assessment periods. Each subtest and composite score of the participant was compared to CTOPP's statistical norms, across age and grade equivalencies to determine clinical gains following program participation (Wagner, Torgesen, & Rashotte, 1999).

Engagement: Momentary Time Sampling Analysis.

Momentary time sampling procedures were used to describe the average percent engagement and average percent of overall off-task behaviour across all program sessions. Off-task behaviour was specifically examined to determine whether one type of off-task behaviour was more common than another (i.e., motor, vocal, or passive). Daily average percent engagement and off-task behaviour percentages were also calculated, graphed, and visually analyzed to see if any trends emerged. Descriptive statistics were calculated from the daily total duration of exposure to HeadSprout lessons.

Participant Self-Rating of Enjoyment Analysis.

The participant rated his enjoyment of the HeadSprout program the same for each

session. If variability in participant enjoyment ratings ensued, the following analysis would have been used: the participant's self-rating of enjoyment would have been graphed daily and visually analyzed to see if any trends emerged. An average self-rating of enjoyment would have been reported, and the results would have been compared visually and numerically (overall average) to the findings obtained from the perceived enjoyment ratings, in addition to perceived engagement, and level of assistance required.

Perceived Engagement, Enjoyment, and Level of Assistance Analysis.

Perceived Engagement and Perceived Enjoyment results were analysed using the same procedure. Each perceived rating was averaged for each daily session, graphed, and visually analyzed to see if any trends emerged across program sessions. Ratings were also averaged to represent a total average perceived rating for all 27 program sessions. Perceived rating data sheets were then coded to form 12 activity categories (Click on sound/word, Find sound in word, Blend sounds/words, Find sound/word [array 3-4], Click and say sound/word, Picture Comprehension, Read word/sentence/story out loud, Sound-Word identification match [array 3], Yes-No target sound/word, Grammar, Blend Nonwords, Sound-Nonword identification match [array 3]). All ratings were averaged across activity type, graphed, and visually analyzed.

Qualitative Analysis: Enjoyment Rating Follow-up Questions, Field Notes, and Reflection Notes.

All three methods of qualitative data collection were compiled collectively for analysis, as primary review revealed several similarities across all data sources. Qualitative analysis followed the general process set out by Harding (2013): all data were: 1) sorted and coded regarding relevance to the research questions on engagement and/or enjoyment; 2) electronic notes were compiled with all relevant data to each research question; 3) any repetition across qualitative data sources was eliminated; 4) electronic notes were read, coded, and electronically recorded according to categorical similarities, common themes, or observable differences; and 5)

an electronic summary was written for each theme with respect to the research question the data addressed.

Treatment Integrity.

To measure the extent to which the program was carried out as planned, treatment integrity was calculated after each session using the following steps: a) the researcher used the treatment integrity form to record if a procedural step occurred (opportunity) and if it was correctly implemented, b) the researcher recorded a check mark if the opportunity occurred, recorded "N/A" for not applicable, and an "X" mark if the procedural step was not followed correctly. Please refer to the sample treatment integrity form in Appendix S. Percentage of treatment integrity was calculated by dividing the number of steps the researcher, "…completed correctly during a session by the total number of steps completed" (Cooper et al., 2007, p. 237). Percent of treatment integrity was reported as an average for all program sessions, in addition to reporting the range.

Treatment integrity results calculated by the researcher indicate an average of 98.05% treatment integrity, ranging between 88.9% and 100%. Review of the forms indicates the only incorrectly performed procedural step was least-to-most prompting during the HeadSprout book readings. Anecdotal evidence indicates that during the seven program sessions with less than 100% treatment integrity the researcher used a most-to-least prompting technique during the book reading to ensure errorless reading.

Interobserver agreement (IOA) of the procedural integrity was intended to be calculated for 30% of all program sessions by having a second observer watch and code the treatment integrity of randomly selected videotaped sessions, as suggested by Cooper et al. (2007). Due to time constraints and limited availability of a second observer, IOA was not calculated to validate the treatment integrity findings. Limitations of this method will be discussed in Chapter 5.

Chapter 4

Results

For nine weeks, the participant attended the reading program for three days a week at Brock University. The primary goal of this thesis research was to determine if clinical improvements in phonological awareness scores would be observed in a seven year old child with ASD following a nine-week reading program using HeadSprout Early reading program. Phonological awareness was measured using five subtests of the Comprehensive Test of Phonological Processing (CTOPP): Blending Words, Elision, Blending Nonwords, Segmenting Nonwords, and Segmenting Words. The secondary goal was to examine the extent of child engagement with the HeadSprout program and to describe how the child enjoyed the program. Child engagement was measured quantitatively using momentary time-sampling and perceived ranking of engagement procedures. Enjoyment was also measured quantitatively through participant self-ratings and perceived ratings of enjoyment. Finally, qualitative field notes were collected during each program session to reflect on the participant's engagement and enjoyment with the HeadSprout reading program. A detailed examination of the results of each data collection measure will be presented in relation to the specific research question it addresses.

1. Does HeadSprout Early Reading significantly improve the phonological awareness score of a child with ASD?

Comprehensive Test of Phonological Processing.

The Comprehensive Test of Phonological Processing (CTOPP) was used to measure phonological awareness of the participant across three time samples: January 2014 (Pre-test), May 2014 (Mid-test), and June 2014 (Post-test). Please note the unequal time distribution between pre- and mid-test is due to difficulty recruiting eligible participants. The original program start date was anticipated to be in February 2014, however after an unsuccessful second wave of recruitment efforts in February and March 2014, the research program began in April

2014. This explains the unequal distribution of time between pre-and mid-test.

Raw scores and percentile rank scores for both the phonological awareness composite (PAC) and alternative phonological awareness composite (A-PAC) measures of the CTOPP are presented in Table 1. The phonological awareness composite combines measures of blending and elision subtests, while the alternative phonological awareness composite combines measures of blending nonwords and segmenting nonwords. Please refer to Appendix U for confidence intervals for CTOPP composite and subtest scores.

Phonological Awareness Composite.

As illustrated in Table 1, the participant's raw scores on the phonological awareness composite (PAC) maintained from pre- to mid- test (85 and 85 respectively), and increased at post-test (94). A more meaningful interpretation of these results can be made when comparing the pre-, mid-, and post-test percentile rank scores on the PAC: prior to beginning the reading program, the participant scored at the 16th percentile on measures of PAC, which increased to the 35th percentile at post-test. This indicates that following a 9 week reading program, clinical gains were made on the PAC, where the participant moved from one standard deviation below the mean to within the normal range at post-program assessment. Despite scoring below the mean after program completion, these gains suggest positive increases on the participant's phonological awareness ability after completing the reading program. Raw scores and percentile ranks on each subtest of the PAC score will be discussed in more detail later in this chapter.

Table 1.

Phonological Awareness Raw Scores and Percentile Rank Scores: Pre-, Mid-, and Post-Test

	Raw Composite Scores			Percentile Rank Scores		
	Pre-Test	Mid-test	Post-test	Pre-test	Mid-test	Post-test
Phonological Awareness Composite (PAC)	85	85	94	16th	16th	35th
Alternate Phonological Awareness Composite (A-PAC)	82	85	64	12th	16th	1st

Alternate Phonological Awareness Composite.

As illustrated in Table 1, the participant's raw scores on the alternative phonological awareness composite (A-PAC) increased from pre- to mid- test (82 and 85 respectively), which decreased at post-test (64). These results indicate that from the pre- to mid-test, the participant increased from the 12th percentile to the 16th percentile on the alternative measures of the phonological awareness composite, yet substantially decreased at post-test to fall within the 1st percentile on A-PAC measures.

These results are quite interesting. Following program completion, the participant's gains on measures of alternative phonological awareness at mid-test, were not sustained at post-test. This reduction in phonological awareness skills, as measured by the A-PAC, suggests that exposure to the reading program either reduced the participant's ability to use these skills or suggests a flaw in the testing procedure. A more detailed examination of the raw scores and percentile ranks on each subtest of the A-PAC within Chapter 5 may help explain these findings.

Elision Subtest.

As illustrated in Table 2, the participant's raw scores on the elision subtest maintained

from pre- to mid- test (4 and 4 respectively), and increased at post-test (6). These results are more meaningful when comparing the pre- and post- elision percentile rank scores: prior to the reading program, the participant's scored on the 16th percentile on measures of elision, which increased to the 37th percentile following program completion (post-test). This suggests that the reading program may have contributed to clinical gains on the participant's ability to perform elision tasks as measured by the CTOPP, where the participant moved from one standard deviation below the mean to within the normal range at post-program assessment.

Table 2.

Phonological Awareness Raw Scores and Percentile Rank Scores: Pre-, Mid-, and Post-Test

	Raw Scores			Percentile Rank Scores		
Subtest	Pre-test	Mid-test	Post-test	Pre-test	Mid-test	Post-test
Elision	4	4	6	16th	16th	37th
Blending Words	6	7	8	25th	25th	37th
Blending Nonwords	4	5	8	25th	37th	63rd
Segmenting Nonwords	2	2	0	9th	9th	2nd
Segmenting Words	0	0	5	5th	5th	25th

Blending Words Subtest.

Results indicated that the participant's raw scores on the blending words subtest increased by one from pre- to mid- test (6 and 7 respectively) which continued to increase at post-test (8) as illustrated in Table 2. Translating these raw scores into percentile ranks demonstrates that the participant moved from the 25th percentile at pre-test to the 37th percentile

at post-test. This suggests that the reading program may have contributed to an increase in the participant's ability to perform blending word tasks, as measured by the CTOPP. Specifically, the participant moved from one standard deviation below the mean at pre-program assessment to within the normal range at post-program assessment.

Blending Nonwords Subtest.

Results demonstrated that following the reading program, the participant demonstrated an increase in his ability to blend nonwords, as measured by the CTOPP. As illustrated in Table 2, the participant's raw scores on the blending nonwords subtest increased by one from pre- to mid-test (4 and 5 respectively), which continued to increase at post-test (8). These scores represent clinical gains in the participant's ability to blend nonwords, following program completion. Specifically, the participant moved from the 25th percentile at pre-test, to the 37th percentile mid-program, to the 63rd percentile at post-test. This indicates that following program completion, the participant demonstrated substantial and meaningful clinical outcomes on measures of nonword blending measured by the CTOPP, where the participant's score moved from one standard deviation below the mean at pre-program assessment, to fall within the normal range and above the mean at post-program assessment.

Segmenting Nonwords Subtest.

Despite increases in the participant's ability to blend nonwords, the results of the segmenting nonwords subtest appear to be responsible for the pre-post-test decrease in raw and percentile scores on the Alternative Phonological Awareness Composite (APAC) measure of the CTOPP. As illustrated in Table 2, the participant's raw scores on the segmenting nonwords subtest maintained at two at both pre- and mid-test. However, these raw scores decreased at post-test assessment to a raw score of 0. These results indicate that the participant's ability to segment nonwords fell from the 9th percentile at pre- and mid-test to the 2nd percentile at post-test. These results indicate that both pre- and post-program, the participant's ability to segment

nonwords fell well outside the normal range, with post-assessment scores falling two standard deviations below the mean. This finding may reflect that the participant was only introduced to nonword activities during lesson 35 (session 25), and that the HeadSprout program does not explicitly teach segmenting in the way assessed by the CTOPP. This phenomenon will be discussed in further detail in Chapter 5.

Segmenting Words Subtest.

The results of the segmenting words subtest indicate increases in the raw scores and clinical gains. As illustrated in Table 2, the participant's raw scores on the segmenting words subtest maintained at 0 at pre- and mid-test, and increased at post-test with a raw score of 5. As the participant's ability to segment words moved from the 5th percentile to the 25th percentile at post-program assessment, it can be concluded that clinical gains were made. As measured by the CTOPP, these results indicate that following program completion, the participant's ability to segment words moved from one standard deviation below the mean pre-program assessment, to fall within the normal range at post-program assessment.

2. Participant Engagement: How does the child engage with HeadSprout Early Reading?

Participant engagement with the HeadSprout program was evaluated with two quantitative data collection measures during all 27 program sessions: Momentary Time Sampling and Perceived Participant Engagement. Qualitative observations of participant engagement were also collected though qualitative Field Notes and Researcher Reflection Notes.

Momentary Time Sampling.

A 15 second momentary-time sampling procedure was used post-hoc to calculate the percent the participant was on- and off-task. After data collection was complete, the researcher coded videos of the participant using the HeadSprout program to calculate percent engagement. This method also included three subcategories to determine what the participant was doing when

off-task: was the child engaged in a) passive off-task behaviour, b) engaged in motor-off-task behaviour, or c) engaged in verbal- off-task behaviour. Please refer to Appendix J for these operational definitions. Results of the momentary time sampling analysis revealed that the participant was engaged with the computer lesson an average of 94.5 % of the time, and off-task for 5.5 percent (Table 3). A visual analysis of the daily average percent of engagement and daily average percent off-task behaviour, located in Figure 1, demonstrates little variability in the data. This indicates that the average percent engagement and average percent off-task behaviour are accurate and non-skewed representations of the data.

Table 3.

Average Percentage Engagement and Off-Task behaviour during HeadSprout computer lessons

	Overall		Specific Off-task Behaviour		
	Engaged	Off-task	Motor	Vocal	Passive
Average Percent	94.5	5.5	1.0	2.2	2.3

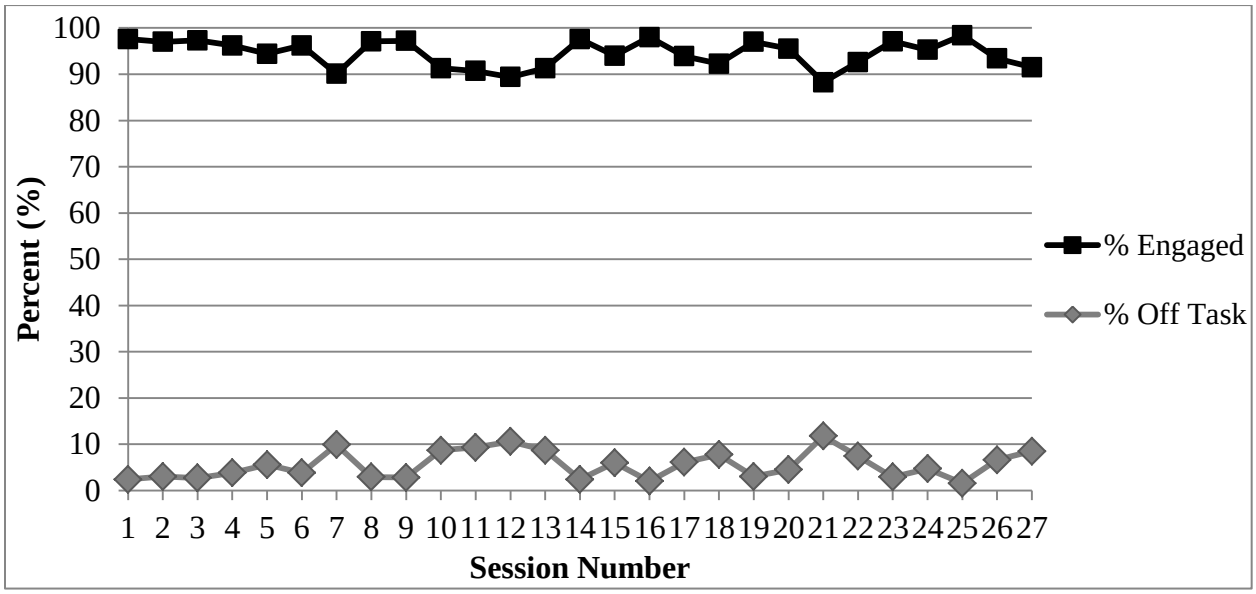


Figure 1. *Average Percent Engagement and Off-Task Behaviour across sessions.*

As illustrated in Figure 2, it appears that the participant was more likely to be engaged in off-task vocal or passive behaviours, as opposed to off-task motor behaviours during the average 5.5% of the time the participant was off-task. This indicates that the participant engaged in varied off-task behaviours, rather than one specific form, such as vocal stereotypy.

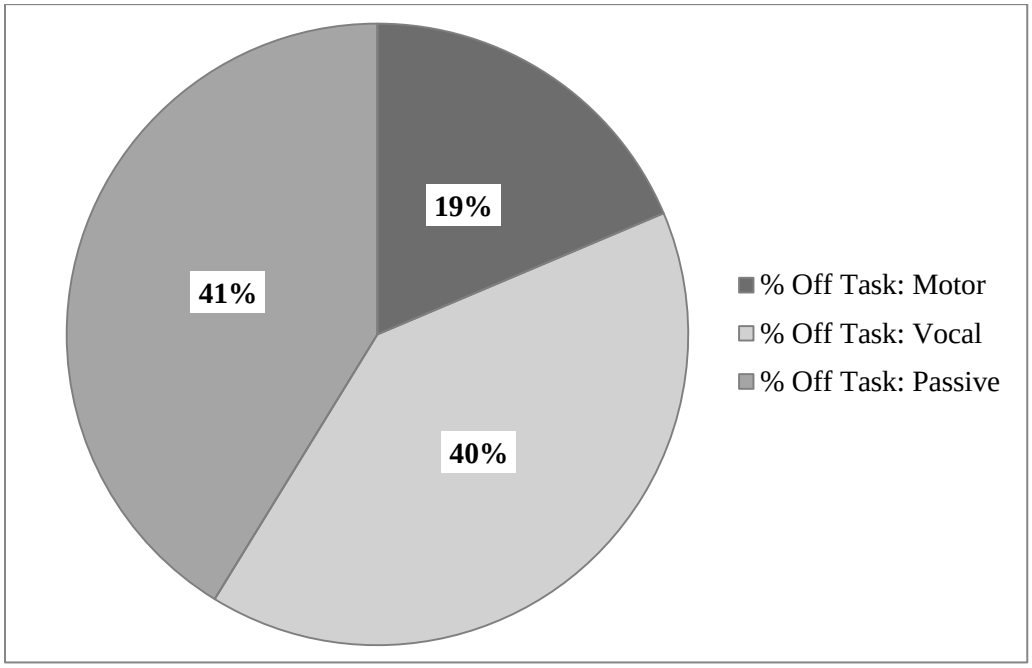


Figure 2. *Average Type of Off-task Behaviour across sessions: Motor, Vocal, and Passive.*

A visual analysis of Figure 3, demonstrates substantial variability in off-task behaviour across sessions. This indicates that there is no trend or pattern in the behaviour of the participant while being off-task, suggesting that there is no specific form of off-task behaviour that may have impeded with participant engagement throughout the computer program.

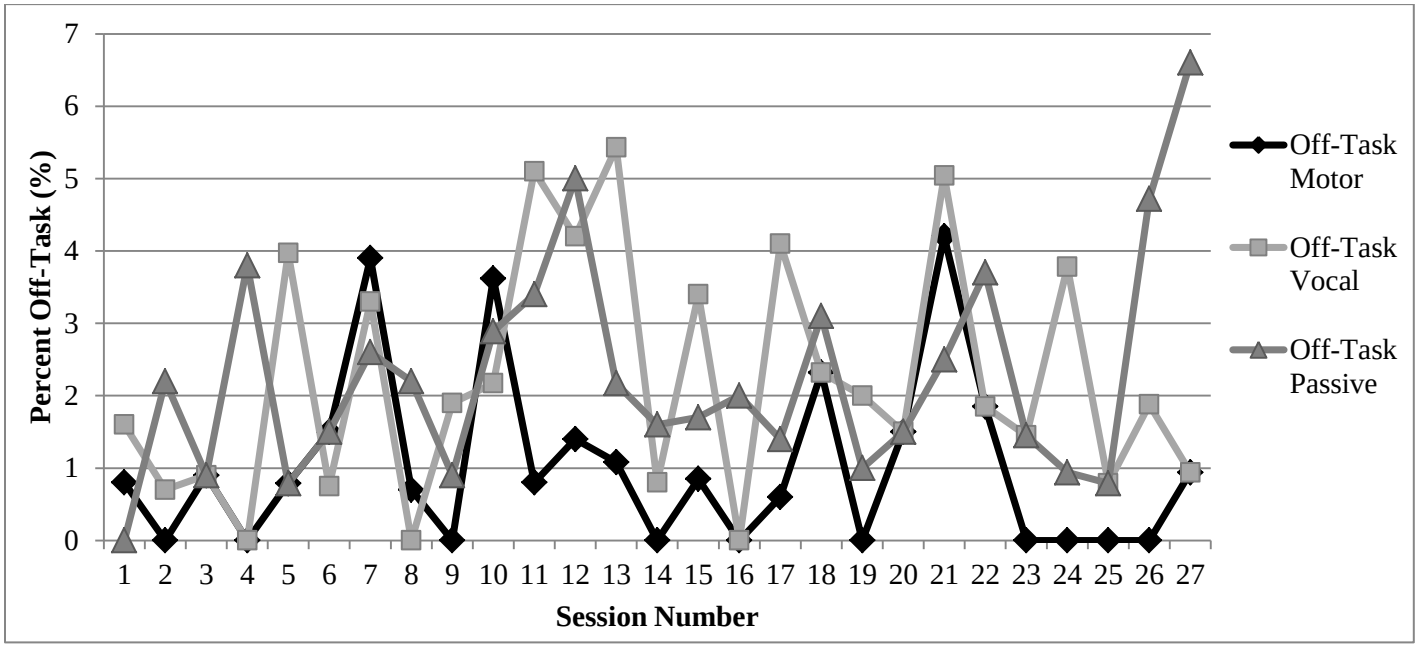


Figure 3. *Daily Percent of Motor, Vocal, and Passive Off-Task Behaviours across sessions.*

Perceived Participant Engagement.

The second measurement of participant engagement consisted of the primary researcher ranking the child's engagement within each activity in the HeadSprout lesson. Please refer to Appendix O for operational definitions of engagement rankings. Perceived ratings were averaged, graphed, and visually analyzed to see if any trends emerged across program sessions and averaged to represent a total average perceived rating for all 27 program sessions.

Results of the perceived engagement rating analysis revealed that the participant was engaged with the computer activities an average rating of 4.98 (range 4 to 5). This indicates the primary researcher perceived the participant to be engaged with the program an average of 60 percent or more of the time. Visual inspection of the average perceived engagement rating across all program sessions (Figure 4) demonstrates little variability across sessions, and thus represents the average engagement rating of 4.98. This analysis also reveals that for 22 of 27 program sessions the average perceived engagement rating was 5, indicating that during the

session the participant was on average engaged with the HeadSprout program 80 percent or more of the time.

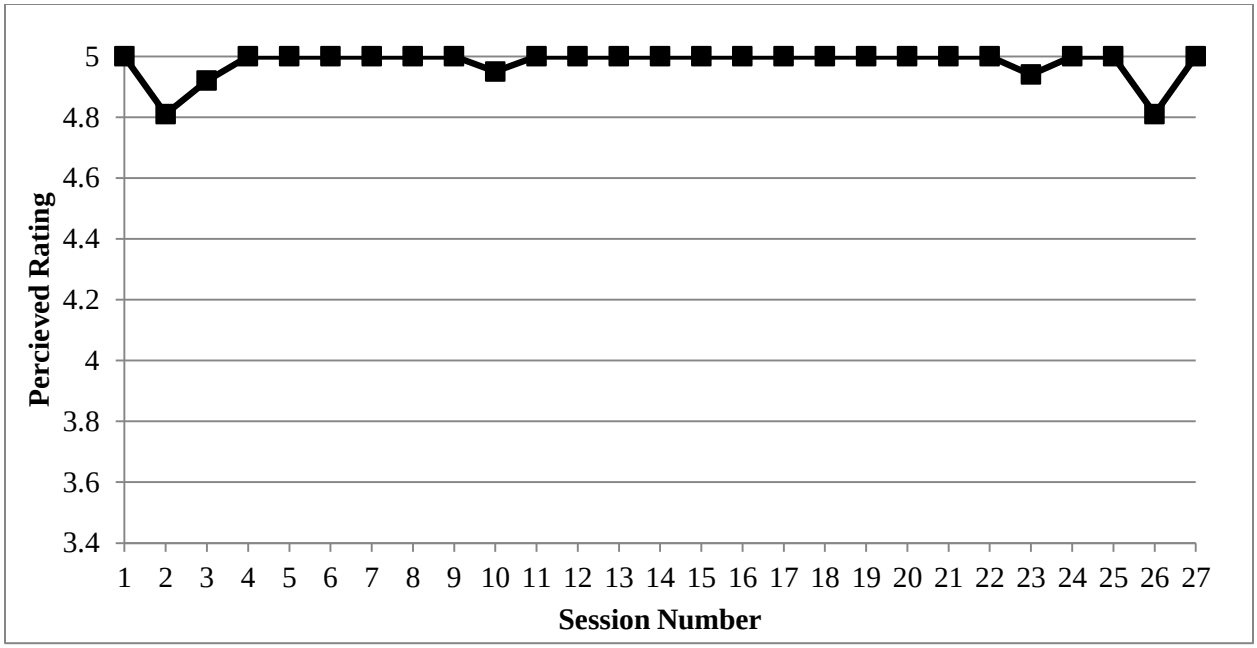


Figure 4. *Average Perceived Engagement Rating across Sessions.*

A secondary analysis was conducted to examine if any differences in perceived engagement were apparent across the type of activity the participant was asked to complete during the computer program. As illustrated in Figure 5, eight of twelve activities were rated with a score of 5. Four activities had an average perceived engagement rating below five, where the "click on sound/word" activity had the lowest perceived engagement rating with a score of 4.93. This activity reflects the lowest perceived rating of engagement however, it still represents a high percent of participant engagement and thus demonstrates that the activities within HeadSprout program appeared to be engaging for the participant.

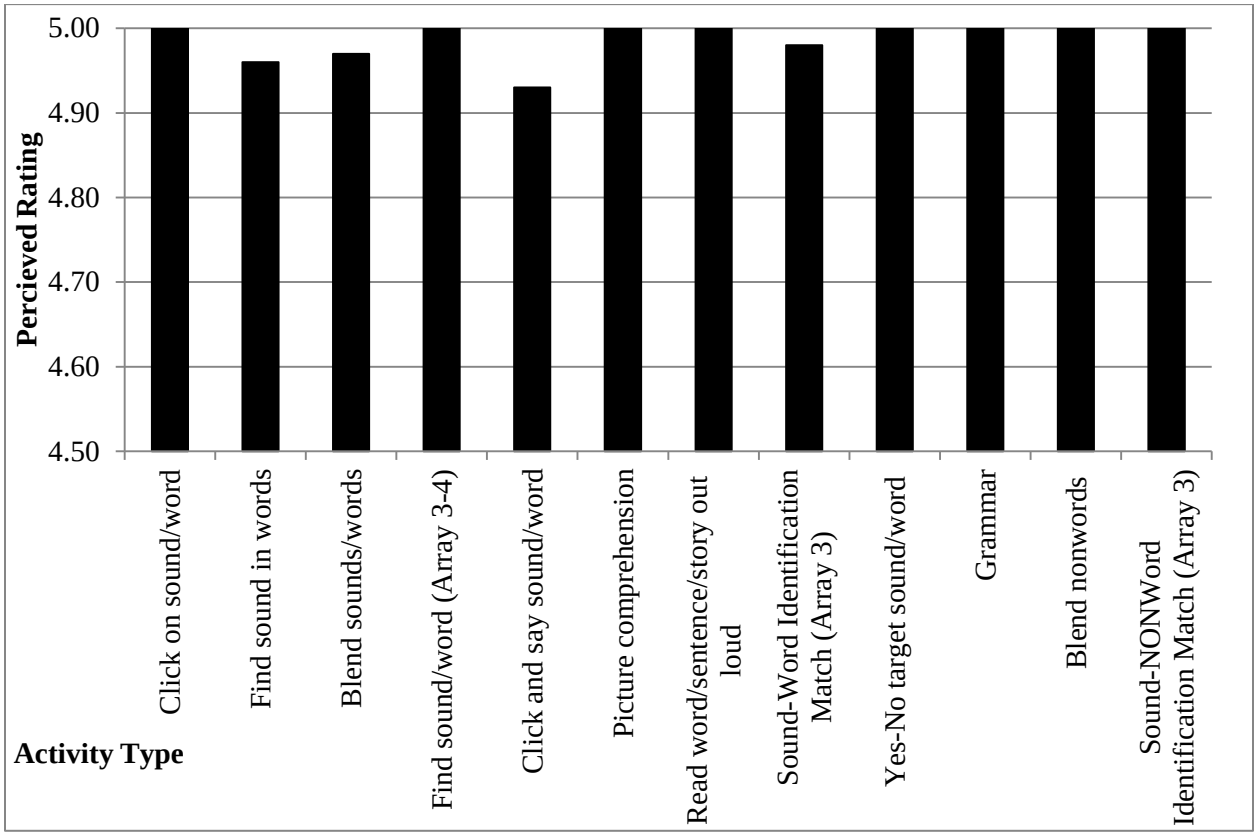


Figure 5. *Average Perceived Engagement Rating across Activity Type.*

Qualitative Reflections on Engagement.

After program completion, qualitative data were analyzed using a five step process adopted from Harding (2013): data were sorted and coded, notes were compiled, repetition across sources was eliminated, notes were read and coded according to categorical similarities or observable differences, and a summary was compiled for each theme with respect to the research question the data addressed.

Four specific themes emerged within the qualitative observation and researcher reflection notes regarding participant engagement: 1) simplicity of instructions, 2) scaffolding instruction to the participant's level, 3) high variety of activity and trials, and 4) built in visual cues and reinforcement. These themes specifically reflect components of the HeadSprout program that may have aided in high percentages of participant engagement.

Simplicity of Instructions.

The HeadSprout framework uses the same activity structure and instructions across all episodes while varying skill targets and systematically increasing difficulty. Several components of this framework appeared to assist with the participant's engagement with the HeadSprout program. The simplicity and clarity of the instructions in addition to the familiar pattern and structure of activities used throughout the entire HeadSprout program appeared to capture the participant's attention and maintain his engagement throughout the session. For example, when the HeadSprout program introduced a speak out loud activity, the participant would often say "speak out loud, my favourite" (session 7). To the researcher this indicated that the participant was familiar with the framework and the expectations of him throughout the lesson, and he was engaged from the start. The instructions and framework appeared to simply capture the participant's attention and continue to maintain his engagement enabling him to process the instructions independently without assistance from the primary researcher.

Despite the simplicity and repetition of instructions and activities encouraging participant engagement with the program, extended use could be responsible for a decline in participant engagement specifically during activity instructions. Part way through the program, the participant appeared to be less engaged during the instructions than during activities. For example on Session 18, the participant was engaged in off-task vocal behaviours during the instructions. The researcher prompted the participant to listen to the instructions so he knew which target word he should be looking for during the upcoming activity. This demonstrates how the repetitive and familiar framework of the HeadSprout could be potentially problematic: the participant may have been less engaged during the instructions because he already knew what to do; this could be problematic if the activity varied slightly from what the participant expected, and possibly result in more errors than if the participant was engaged with and receptive to the instructions. Overall, the simple and repetition in instructions and activity framework was

helpful in engaging Kyle with the HeadSprout computer lesson.

Scaffolding Instruction to the Participant's Level.

Qualitative data suggest that participant engagement may have been supported by the program's ability to scaffold instruction and activities to an appropriate level of difficulty for the participant. Specifically, the use of stimulus and prompt fading appeared to impact the participant's engagement. The program slowly builds in difficulty, for example, by adding more words into the visual field for selection, or by using stimulus fading over a series of trials to make activities progressively harder. For example, when a participant is asked to find a target word in an array of 4 words, the target word is first significantly highlighted in bold text to errorlessly prompt the child to identify and select the correct word. As the next seven trials progress, the target word stimulus is systematically faded to appear more like the other words in the array, allowing for the participant to learn to select the target word from the array in the absence of stimulus prompts. Presenting the task in such a simple and effective way with these subtle response cues helped to keep the participant engaged while learning to complete activities independently. Qualitative data therefore document the possible potential of HeadSprout to engage participants by using stimulus fading in activities to scaffold instruction to an appropriate level of difficulty.

High Variety of Activity and Trials.

The participant completed an average of 17.18 activities per session (ranging from 10 to 30). This relatively high variety of activities suggests that the participant was engaged with the program during the 30 minute time block. HeadSprout was also creative and subtle in achieving high repetition of target words while maintaining the participant's engagement. For example, rather than asking the child to read the same sentence multiple times in one activity, the program would ask the child to click on the word, hear the computer to say the word, find the word in a sentence, say each word out loud, and then find the matching picture for the sentence. Other

times, the student may read a story of five sentences a total of four times within one activity. By interjecting animated scenes between each trial, the participant is less aware of the high number of trials within the activity. Specifically sequencing the activities in this manner appeared to maximize Kyle's engagement, as it allowed for animations and celebrations throughout while achieving a high number of trials and repetition of essential skills.

The HeadSprout program also appeared to engage the participant by asking him to do more than watch the computer screen and click a mouse. During speak-out-loud activities for example, the participant may be asked to click on the word, say the word, and then find the word. Similarly, during blending activities, the participant was asked to say parts of the word out loud slowly, and then quickly as a red line moved below the word to signal the user when to say which sounds. The participant appeared to become more engaged by performing the same task through multiple modalities: watch and listen to the computer say each sound slowly in the word, and then practice it out-loud on his own to read all parts of the word together. Overall, the participant may have been engaged with HeadSprout because the program asked him to respond using multiple modalities while incorporating a high variety of activities and trials within the program.

It is important to note that, on occasion, some activities appeared to be very repetitive and the participant was less engaged. In session 9 for example, one activity extended over 3 minutes long. The participant appeared to be engaged for the first two minutes, however the participant engaged in more off-task behaviours when the activity was extended and repeated beyond 2 minutes. In this instance, the participant was creative in trying to keep himself engaged by trying to read all the words that he was presented with. Despite this example demonstrating the participant's initiation of his own engagement, on occasion repetitive activities appeared to encourage less participant engagement with the program and more off-task behaviour. This data suggests that the participant was more engaged when a high variety of short duration activities

were included within the HeadSprout lesson.

Built in Visual Cues and Reinforcement.

The HeadSprout program includes animated scenes, music, and visual cues which appeared to keep the participant engaged. The participant appeared to learn that following each activity an animated scene with the characters and music would occur. As these characters and music were enjoyable to the participant, he was fully engaged with the program after completing an activity. The participant would also share comments suggesting his engagement with the program and say to the researcher, "I wonder what will happen" (Session 5). Another component that appeared to aid in participant engagement with the HeadSprout program was the use of built in visual cues. The HeadSprout program often uses visual representation, for example, there are 10 flowers that must become coloured for the activity to be complete. When the participant noticed these visual cues, he became more engaged with the program because he knew how many more clicks he must do in order to complete the activity and access animation and musical reinforcement. This visual representation seemed to encourage and motivate the student to complete the task and anticipate the animated celebration, as he would often exclaim, "only two left!" (Session 20).

In summary, results from the momentary time sampling and perceived rating methods indicate a high level of participant engagement with the HeadSprout program. Qualitative observation and reflection notes suggest that the high percentage of participant engagement may be related to specific components built into the HeadSprout program framework. Specifically, participant engagement may have been elicited by factors such as the simplicity of instructions, appropriately scaffolded activities to the participant's level, variety of activity and trials, and the built-in visual cues and reinforcement.

3. Participant Enjoyment: Is HeadSprout Early Reading an Enjoyable Reading Activity for a Child with ASD?

Two nominal quantitative methods of data collection were used to assess participant enjoyment with the HeadSprout program during all 27 program sessions: Participant Self-Rating of Enjoyment and Perceived Participant Enjoyment. Data on participant enjoyment were also collected through qualitative Field Notes and Researcher Reflection Notes.

Participant Self-Rating of Enjoyment.

Enjoyment of the HeadSprout computer program was evaluated by asking the participant to complete a self-report rating scale after completing the HeadSprout computer program section of each session. The participant was given a file folder with Velcro spots for up to 5 stars and he was taught to select and place the number of stars that reflected his enjoyment of the HeadSprout lesson (Appendix L).

For the first nine sessions of the program the researcher walked the participant through the meaning of each of the star ratings and then asked him to independently select the number of stars that represented his enjoyment of the program. By the 10^{th} session the participant could independently identify and explain what each of the five stars represented, and on the 12^{th} session the participant began to independently find the star rating folder, say what each star meant, and select the star that represented his enjoyment of the HeadSprout program for that day.

Results revealed that the participant rated his enjoyment of the HeadSprout program with a value of four every session indicating the participant liked the computer activity. Qualitative observations provide insight into the potential limitations of this method, indicating that perhaps the self-rating enjoyment activity became a routine where the participant would always select four stars. For example, on the last session the primary researcher asked the participant why he gave the computer game a rating of four. The participant stated, "Because I liked it, I always like the computer game" (Session 27). As supported by qualitative data discussed further on,

this demonstrates that the participant enjoyed the computer and suggests the participant would want to use the computer game again (a rating of 5 stars).

Perceived Participant Enjoyment.

The second quantitative measurement of participant enjoyment consisted of the primary researcher rating the child's enjoyment within each activity of the HeadSprout lesson. Enjoyment ratings were operationalized to compare each session's average enjoyment rating to the participant's self-rating of enjoyment, and to assess the participant's enjoyment of particular activities within the HeadSprout program. As such, enjoyment ratings were operationalized as using the same definitions for the self-rating activity (Appendix O).

Results of the perceived enjoyment rating analysis revealed an average rating of 4.86 (range 2-5) across all program sessions. This indicates that the participant appeared to like or love the activity and would likely want to complete the activity again in the future. Visual inspection of the average perceived enjoyment rating across all program activities and sessions (Figure 6) demonstrates variability in enjoyment ratings early in the program session which appears to become more stable after session 10. This indicates that the participant was perceived to enjoy the program activities more, and more consistently enjoyed the program activities during the second half of the sessions.

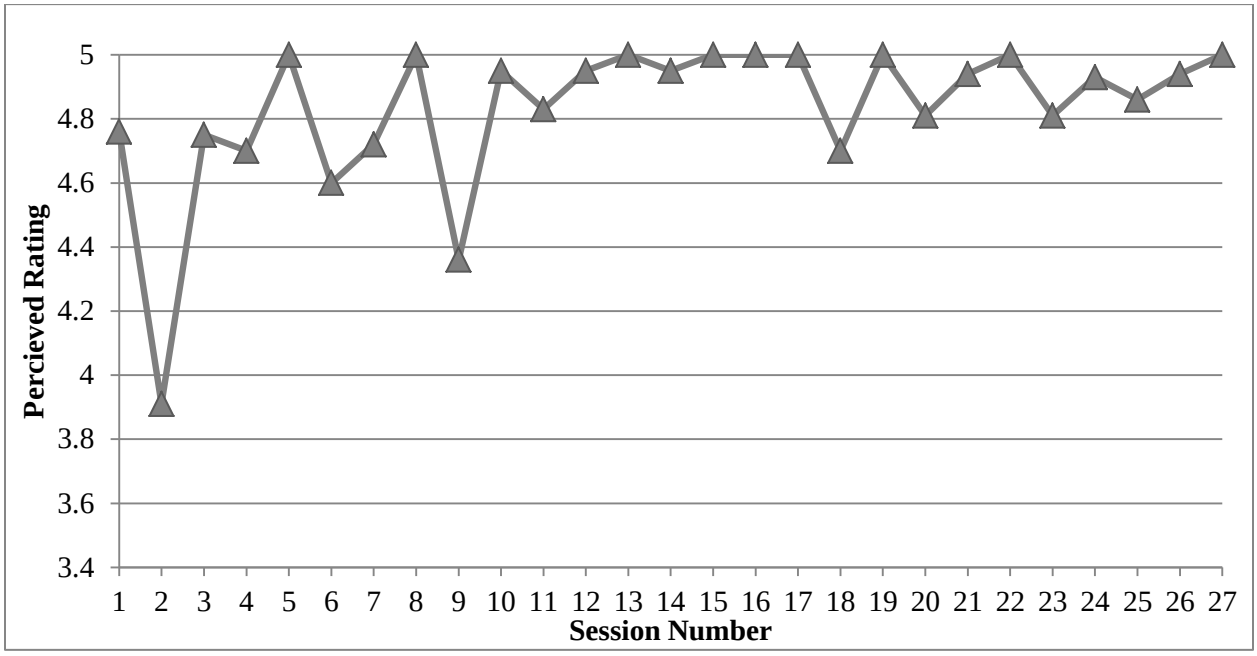


Figure 6. *Average Perceived Enjoyment Rating across Sessions.*

A secondary analysis examined if any differences in perceived enjoyment were apparent across the type of activity the participant was asked to complete during the HeadSprout computer program. As illustrated in Figure 7, there appears to be some variability among enjoyment ratings across all activity types. Five activities were rated with an average enjoyment score of 5 and three activities ("click on sound/word", "find sound/word (array 3-4)", and "click and say sound/word") scored lowest on average enjoyment with scores of 4.66, 4.72, and 4.8 respectively. Despite these three activities ranking the lowest for participant enjoyment, these rankings do reflect a meaningfully high percent of overall participant enjoyment with all activities in the HeadSprout program.

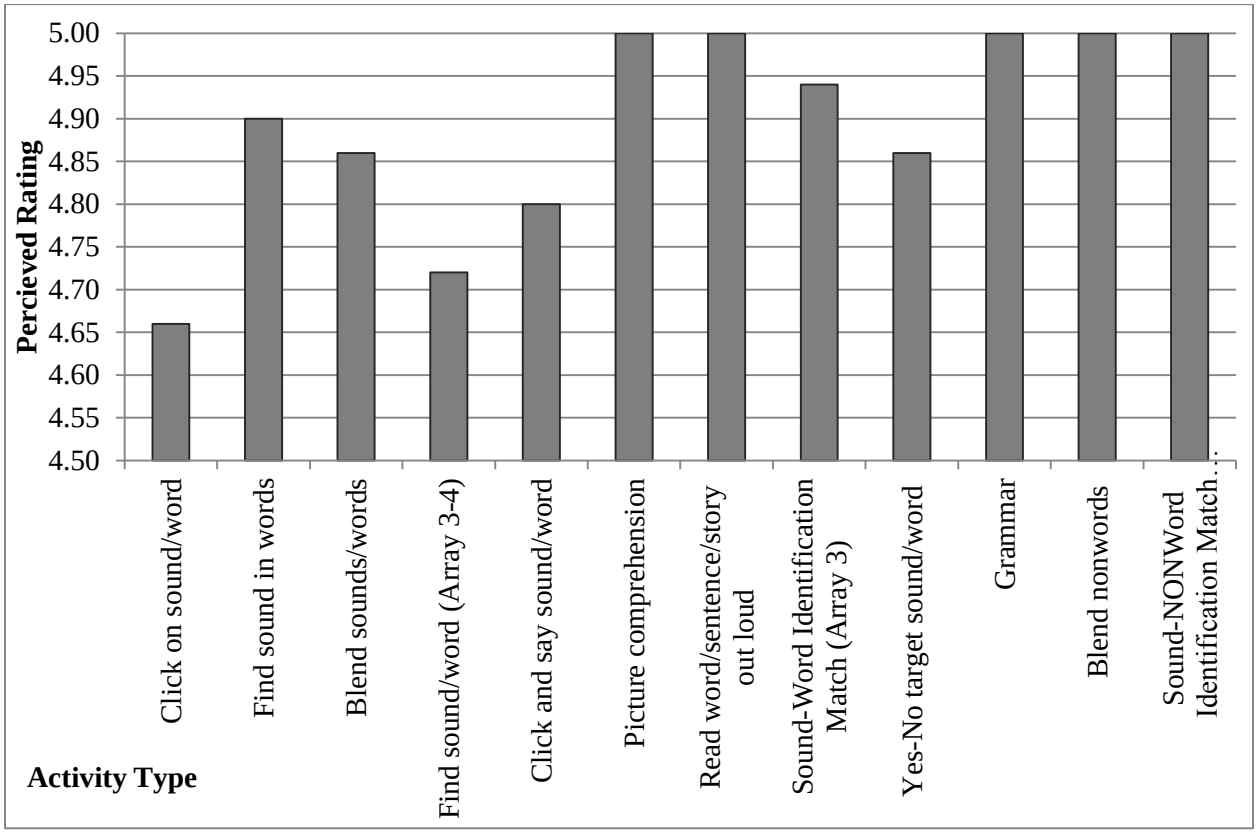


Figure 7. *Average Perceived Enjoyment Rating across Activity Type.*

Qualitative Notes on Enjoyment.

After several sessions, it became evident the participant enjoyed the HeadSprout program when he would say, "can we get started now?"(Session #8,10), or when he was told it was time to start the computer game and he would say, "yay!" (Session 25). Two sources of data provide insight into the participant's enjoyment of the HeadSprout program: session observation notes and participant responses to questions during the rating activity. After each self-rating activity the participant was asked two questions: "what did you like most about our work today?" and "what did you like least about our work today?" In responding to these questions a routine response emerged, "I liked it all. " As the participant became more comfortable with the researcher, he elaborated on his routine response to clarify specific aspects of the program that he liked and did not enjoy. Data from session observation notes and participant responses to these

questions were compiled and analyzed using the five step process adopted from Harding (2013), as previously mentioned. Four specific themes emerged regarding participant enjoyment of the HeadSprout program: 1) animation and characters, 2) HeadSprout virtual worlds, 3) auditory components of HeadSprout, and 4) not enjoyable: error correction. These themes specifically reflect elements that may have contributed to the participant's enjoyment of using the HeadSprout program.

Animations and Characters.

The participant specifically appeared to enjoy the music and sounds used throughout each sessions and would often sing along, dance, smile or laugh throughout these components of the HeadSprout Program. The participant often described that he liked the music and the characters in the HeadSprout program. It became apparent that the participant liked specific music videos or cartoon animations that appeared at the end of each activity. For example, across several sessions the participant said he liked when the bunny popped up and said "mommy". Another time, he expressed that he enjoyed the tree scene at the end of the activity stating, "I love the tree one where things fall down from the tree" (Session 27). He also discussed how he liked watching the dinosaurs climb up the mountain at the end of an activity (Session 6). On several occasions, the participant expressed how he liked the music throughout the episodes. During one session in particular, the participant told the researcher that after the previous session he had gone home and looked up the singing turtles on YouTube because he liked them so much (Session 10). The participant also discussed how he liked the characters. He explained that he liked the aliens (like "San, the one with three eyes" Session 13), the new characters in the jungle theme, and that he thought that one character in particular, Trish, was "cute" (Session 21). Together, this suggests that the participant enjoyed the characters, cartoon animations and music present throughout each HeadSprout episode.

The participant seemed to be least interested in a feminine starfish character that was

performing ballet, yet he still enjoyed the music and was interested to see what the animation would entail.

HeadSprout Virtual Worlds.

Throughout the HeadSprout program, a variety of virtual "worlds" or themes are used to introduce new characters and music. The participant appeared to really enjoy the different virtual worlds throughout the program and often expressed that he was looking forward to the next theme. On session 9 for example, the participant appeared to be disappointed that a new virtual world had not begun, by saying, "nope, it's still dinosaurs". The participant also demonstrated his enjoyment of the HeadSprout virtual themes when a new virtual world began, often revealing his excitement by bouncing up and down in his chair and exclaiming, "It's in the jungle this time!", for example (Session 17).

Throughout the 38 sessions completed, the participant completed episodes in the Space, Dinosaurs, Under-the-Sea, Jungle, and Candy-land virtual worlds. One component in particular may have helped foster interest and enjoyment in these virtual worlds: use of the HeadSprout episode map (Appendix T). After an episode was completed, the participant would mark the HeadSprout Episode map with a star. On several occasions when the participant arrived at Brock University, he would ask to look at his map and would make comments about how far we've gone. For example, "I can't believe how far we've went! Outer-space, and then dinosaurs, and then under the sea, and now I think we started the Jungle" (Session 19). This episode map not only permitted the participant to mark down his accomplishments by placing stickers over the completed map, but also to look forward to the next episodes and adventures he would explore with the program. It appeared this map was motivating to the participant to complete more HeadSprout episodes, and allowed him to track his accomplishments which he was proud to share with his parents and sibling (Session 24).

Auditory Components of HeadSprout Computer Program.

The most salient aspect of the HeadSprout program for the participant was his enjoyment of the auditory and vocal feedback provided throughout the programming. He appeared to enjoy the vocal praise provided at the end of each activity by the HeadSprout narrator, such as, "wow, you did it". This form of verbal reinforcement appeared to make the program enjoyable for the participant.

It became evident that the participant also enjoyed another form of auditory feedback provided throughout the HeadSprout program. Specifically, he appeared to enjoy the specific sayings characters stated throughout the animations, such as an alien stating, "wow a customer" (Session 6). After having heard these statements, the participant would smile or laugh, and he would often repeat these sayings throughout the session. For example, while waiting for the next activity's instructions to begin, he might say, "Wow a customer" or say, "you did it!" and laugh (Session 6, 10). The vocal feedback provided by both the HeadSprout narrator and statements from the characters appeared to be particularly enjoyable for the participant.

The participant also expressed his enjoyment when the computer modeled how to say specific sounds and words, specifically during speak-out-loud activities. Each time a speak-out-loud activity was announced the participant would say, "oh, my favourite. " It appeared that the participant enjoyed this activity because it provided lots of auditory feedback throughout the activity; the narrator would model the sound or word, then ask the participant to click and hear the word out loud, and then be able to speak the word out-loud himself. The participant may have enjoyed these activities because of the high frequency of auditory feedback during the speak-out-loud activities. Furthermore, the participant also mentioned, "I like when it say[s], p/ip" (Session 11). This indicates that the participant enjoyed hearing the narrator and himself speak throughout the speak-out-loud activities, and also enjoyed the way the narrator modeled how to say certain words.

This knowledge of the participant's enjoyment of sounds, phrases, positive feedback, and music became valuable to the researcher as a secondary motivator during HeadSprout sessions. Specifically, the researcher could make longer, less interactive activities more interesting by adding in auditory feedback. In many sessions for example, the primary researcher would say the sounds that the participant liked (such as "pr" or "ip") when the participant clicked on the letters, in an attempt to make longer activities more enjoyable and maintain engagement.

The participant's enjoyment of the verbal statements and feedback throughout the HeadSprout program was also problematic in some instances. For example, the participant would often want to laugh, repeat and share the verbal statements from the program with others. Although this is seen as positive for social interactions, as it became a routine for the participant and the researcher to sing certain tunes together and talk about the animated scenes as they were happening, this became problematic when it interfered with listening to the next activity's instructions. Often the researcher would have to prompt the participant to listen to the instructions rather than continue discussing parts of the program.

The participant's enjoyment of the verbal feedback used throughout the HeadSprout program was also problematic when he made mistakes. For example, the participant stated, "I like when it says, 'oops that's not it' " (in reference to the computer; Session 17). Unfortunately, this auditory error correction made the activity counter-intuitive when the participant made errors on purpose; and may have in fact reinforced incorrect responding (Cooper et al., 2007). On several occasions the participant would incorrectly respond on purpose simply to hear the auditory error feedback. The observed frequency of this intentional error making behaviour increased between sessions 17 and 20, demonstrating this auditory feedback may have reinforced the intentional error-making behaviour. This therefore has significant implications for students using the program as a learning tool, especially when using the program in the absence of adult supervision or assistance. It is possible that in the absence of adult supervision while using the

HeadSprout program on Session 20, the participant may have continued to make intentional errors throughout a large portion of the session. One must consider whether the auditory feedback from the program impedes attainment of the goal of the activity since this may not be helping the student to learn.

HeadSprout Stories.

Qualitative data suggests that the participant also enjoyed reading the HeadSprout stories, and often initiated the story time by bringing the book to the researcher. An example of this was when the participant excitedly got out of his chair, smiled, and said, "Now it's time to read the story!" (Session 18). As this quote demonstrates, these stories were something that the participant appeared to enjoy and looked forward to throughout the session. After reading the book twice, the participant brought the book home. Over the course of the 27 sessions, anecdotal evidence suggests that the participant's fluency and speed of reading improved, in addition to his confidence in reading. Anecdotal reports from the participant's parent suggested that his confidence and enjoyment of reading the HeadSprout stories continued within the home.

Not Enjoyable: Error Correction during HeadSprout Episodes.

When the participant was asked what did you like least about our work today, he often responded, "nothing, I liked all the parts". This solidified that there was nothing specific that the participant found difficult or did not enjoy about the computer program. On one occasion however, he expressed how he found the one activity boring because, "he kept saying the same word a million times" (Session 25). This can be explained through the HeadSprout programming error correction procedure: when the user makes an error, the computer program responds to these errors and waits for success until moving on to a more complex activity. During the activity that the participant described as boring, it was because he kept making intentional errors (to hear the verbal feedback from the program "whoops, that's not it"), thus delaying the end of the activity. Once the primary researcher explained this to the participant, he

completed the rest of the activity without errors.

Overall, however, the error correction procedure built into the HeadSprout program was not enjoyable for the participant and was a source of frustration and stress. During some activities, if one or more errors were made or the participant took too long to respond, the activity would re-start. The participant would become frustrated especially if he was trying to complete it correctly for example by reading all the word options before making a selection.

When the participant was required to re-start the activity or lost visual tokens because of too many errors, this would also affect his confidence in his ability to respond correctly. For example, he would be less confident in his responses, and would confirm the correct response with the researcher before selecting the response (asking, "is this it?" Session 7). The impact of this error correction procedure made him nervous to make errors and it often took several questions with full support from the researcher for him to feel confident in his ability to complete the activity correctly.

The following example helps highlight the impact of error correction on the frustration and confidence of the participant. During Session 10, the participant made an error looking for the word 'sand' in an array of 4 words. In response, the participant stated, "I guess I wasn't careful." The next opportunity for the participant to respond, he asked the researcher, "Is this it?", and the researcher scaffolded support by pointing to a word in the array saying, "does that look like it? No." and when the participant placed the cursor over the correct word, the researcher said, "yes that looks like it!". The second opportunity for the participant to respond, the participant clicked quickly, made a mistake, and said in an agitated voice while shaking his hands in the air, "whoops I keep forgetting…Just show, just point to it then [the answer]" (Session 10). Over the next three questions the researcher provided considerable support helping the participant to find the right answer while providing positive statements such as, "you got it, that's right" (Session 10). As this example demonstrates, the error correction procedure

appeared to be a source of frustration or stress for the participant, where his confidence in his ability to respond correctly and independently was impacted. The participant often required high levels of support and praise several questions after the error before feeling confident in his ability to independently respond correctly.

Overall, the results from both qualitative and quantitative data suggest that the participant enjoyed the HeadSprout program, and provided insight into why the participant enjoyed the HeadSprout computer program. These findings complement each other, highlighting that the participant enjoyed the computer program because there were speak-out-loud activities, entertaining animations and characters, and he enjoyed listening to the different sounds and music.

Results Summary

The data indicate that the phonological awareness scores of a participant with ASD increased following the completion of an enjoyable and engaging 9 week reading program using HeadSprout Early Reading. Specifically, the participant's scores on the Phonological Awareness Composite of the CTOPP moved from below the norm (16^{th} percentile) to the within the norm (35^{th} percentile) from pre- to post-program. As demonstrated in Figure 8, the data indicates that improvements on the participant's scores on elision, blending words, blending nonwords and segmenting words occurred after completing a 9 week HeadSprout-based reading program; moving from one standard deviation below the mean to within the normal range post-program assessment. The data also revealed that the Segmenting Nonwords subtest may be responsible for the overall decrease of the Alternative Phonological Awareness Composite (12^{th} percentile pre-program to the 1^{st} percentile post-program). Overall, results suggest that positive clinical gains in the PA scores of a child with ASD occurred after participating in the 9 week HeadSprout-based reading program.

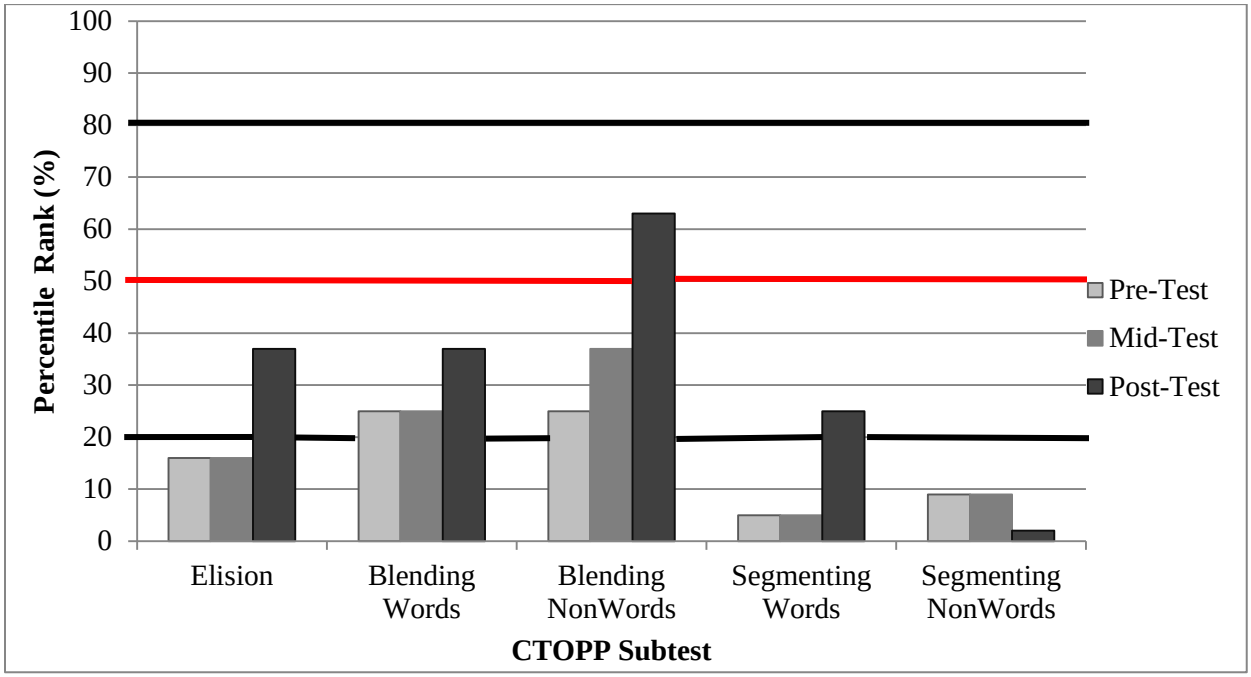


Figure 8. Clinical Gains: Percentile rank scores compared across CTOPP Subtests.

The data indicate that the participant was engaged with the HeadSprout program for 94.5% of each session period. Perceived engagement data underestimated the participant's engagement, suggesting the participant was perceived to be engaged with the program 60% or more of the time. Results from the momentary time sampling and perceived rating methods indicate a high percent of participant engagement with the HeadSprout program. Qualitative observation and reflection notes suggest that high percent participant engagement may be related to the simplicity of instructions, appropriately scaffolded activities to the participant's level, high variety of activity and trials, and the built in visual cues and reinforcement.

Overall, the results from both qualitative and quantitative data suggest that the participant enjoyed the HeadSprout program, and provided insight into why the participant enjoyed the HeadSprout computer program. These findings complement each other, highlighting that the participant might have enjoyed the computer program because there were speak-out-loud activities, entertaining animations and characters, and different sounds and music.

Chapter 5

Discussion

Results suggested that overall, a participant with ASD appeared to be engaged with and enjoy using the HeadSprout Early Reading Program over the course of 9 weeks. Following the research program, the participant demonstrated increases in phonological awareness skills. The following chapter will discuss possible explanations for each finding in relation to the research question, implications for practice, and limitations of the research study.

1. Does HeadSprout Early Reading significantly improve the phonological awareness score of a child with ASD?

Overall, results from the CTOPP demonstrated positive increases in a participant's phonological awareness skills after completing a 9 week reading program consisting of 30 minutes of HeadSprout Early Reading three days a week. These findings are unique, as no other researchers have examined phonological awareness ability, or the phonological awareness ability of a child with ASD after using HeadSprout Early Reading.

Generally, the results found in this study are similar to those reported by other researchers. Huffstetter et al. (2010) for example, demonstrated that 31 typically developing children using the HeadSprout program made substantial gains on tests of early reading skills as measured by the Test of Early Reading Ability, *Third edition* (TERA-3). Despite differences in measurement (TERA-3 measures different early reading skills than the present study; understanding of the alphabet, print conventions and print meaning, compared to phonological awareness), both findings reported student increases from one standard deviation below the mean to average performance post-program (Huffstetter, et al., 2010). Together, these findings demonstrate that using HeadSprout Early Reading may have positive effects on early reading and phonological awareness skills of children at risk for reading difficulties.

These findings also complement results reported by other researchers using HeadSprout Early Reading with children with ASD. Grindle et al. (2013) found that four participants with ASD improved on 6 measures of early reading (word recognition, initial sound fluency, phonemic segmentation fluency, word use fluency, letter naming fluency, and nonsense word fluency), after completing 80 HeadSprout lessons with additional discrete trial teaching over 14 weeks. Whitcomb et al. (2011) found similar positive results on word set reading skills of a student with ASD after completing 23 HeadSprout lessons. Cumulatively, results from the current study, Grindle et al. (2013), and Whitcomb et al. (2011) suggest promising outcomes on measures of early reading for children with ASD after completing at least 23 HeadSprout lessons.

The overall program results also demonstrate beneficial outcomes, despite completing less than half of the entire HeadSprout program (entire program is 80 lessons). Twyman, et al. (2011) found that having completed at least 41 program lessons still produced beneficial outcomes; the present study demonstrated that exposure to 38 HeadSprout lessons produced beneficial outcomes on measures of phonological awareness for a child with ASD. The instructional intensity and robust nature of the skills learned increases within the total 80 lessons, suggesting that participants completing all 80 lessons may demonstrate even greater gains on measures of phonological awareness and early reading skills (Twyman, et al., 2011). Future research should therefore consider examining participant outcomes on measures of phonological awareness after completing more HeadSprout lessons, include a wider measure of early reading skills, and examine follow up scores for children with ASD.

As no researcher to date has examined the change in phonological awareness skills of children with ASD after using HeadSprout Early Reading, a more detailed discussion of the CTOPP results is warranted.

Phonological Awareness Composite.

The results from PAC section of the CTOPP measures were very positive, as the participant demonstrated gains in PAC score from below the norm (16th percentile), to within the average clinical range (35th percentile) from pre- to post-test after 9 weeks of HeadSprout programming. PAC subtests of elision and blending words also demonstrated positive gains, falling within the 37th percentile at post-program assessment. A surprising finding was that the elision subtest increased by this magnitude from pre- to post- test (16th to 37th percentile), as specific elision activities were not addressed within the HeadSprout programming.

Results revealed that the participant's ability to blend words was one of his strongest subtests on the CTOPP. Scoring within the 25th percentile at pre-program assessment, the participant continued to progress at post-program assessment, where he scored within the 37th percentile. Qualitative data specifically acknowledged the participant improved his understanding and use of blending throughout the program. Data indicated that the participant's ability to blend words transferred to novel situations where he was able to independently complete the blending activities with computer prompts, and then apply these to unfamiliar words in the HeadSprout readers. On Session 25 for example, the participant sounded out and blended together the sounds in the word "swinging", a word that had just been introduced within the HeadSprout *Read-with-Me book*. By first learning how to break unfamiliar words down in parts slowly and then increase the speed, the participant was able to blend sounds together to make a new word within the HeadSprout book. From a behavioural perspective, this indicates that the participant had the ability to blend words and transferred this skill to untrained stimuli (Cooper et al., 2007). Similar anecdotal results were reported by Grindle et al. (2013), where one participant's parents reported generalization of blending activities to novel places, such as novel signs posted around his neighbourhood. Together, this provides evidence that using HeadSprout Early Reading may have positive generalization effects to specific skills, such as

blending. Future research should consider examining skill generalization to novel stimuli and settings.

Alternative Phonological Awareness Composite.

Despite the successful increases on the Phonological Awareness Composite, the participant's overall score on the Alternative Phonological Awareness Composite (A-PAC) increased from pre- to mid-test (12th percentile to the 16th percentile), yet substantially decreased to the 1st percentile at post-test. These results are particularly surprising at first, considering the blending nonwords subtest of the A-PAC increased from the below the mean at pre-program testing (25th percentile) to above the mean at post-test (63rd percentile). This substantial reduction in the A-PAC score appears to reflect the decreasing trend in the participant's ability to segment nonwords. Specifically, the participant scored in the 9th percentile pre- and mid-testing on the segmenting nonwords subtest of the A-PAC, which fell to the 2nd percentile post-program testing. Caution must be taken when interpreting the overall A-PAC score, as the substantial clinical gains made on measures of blend nonwords is not reflected within this composite.

Several explanations are possible for the low scores on the segmenting nonwords subtest, despite the significant increases reported for all other CTOPP subtests. First, the segmenting nonwords subtest was the last to be completed on the post-test day. This testing was completed prior to a pizza party celebration after the last session and the participant seemed to be distracted and excited about finishing and celebrating with his family. This result could have been a testing error due to participant distraction or reactivity. Second, the HeadSprout computer program performed little to no observable instruction on segmenting tasks, which may provide an explanation as to why these skills did not improve at a similar magnitude to those measured on the other subtests. As reported by Grindle, et al. (2013) two of their participants also demonstrated decreasing trends in the nonsense word fluency, which they argued could have been attributed to the participants' confusion with what was expected of them, due to the

emphasis on real words within general and HeadSprout reading instruction (Grindle, et al., 2013). The participant's score on segmenting nonwords therefore could be indicative of either or both the lack of instruction from the HeadSprout program and confusion due to general emphasis on real words within reading instruction. Third, this finding may reflect that the segmenting words and segmenting nonwords subtests cover skills which may not have yet emerged for a 7 year old. The norm-referenced CTOPP Examiner's manual indicates that both segmenting nonwords and segmenting words are skills that only begin to develop after 7 years old (TD child), or around grade 2 (Wagner, et al., 1999). Given that the participant demonstrated overall poor phonological awareness scores at pre-test, it is surprising the participant's score on the segmenting words subtest increased at post-program testing. Therefore, maturation is the most plausible explanation for the overall poor scores on measures word and nonword segmentation, as the participant may not yet be developmentally mature to adequately demonstrate the ability to segment words and nonwords. Lack of instruction may also be responsible for the overall low score on segmenting words and nonwords, while testing error, and observer distractibility may have also contributed to the decrease in percentile rank from pre- to post-test on the segmenting nonwords subtest.

Words versus Nonwords.

Previous researchers have also demonstrated that children with ASD and hyperlexia may also be strong nonword readers (Newman et al., 2007). Overall, it appears the participant scored better on word tasks than nonword tasks (25^{th} and 37^{th} percentile, versus 63^{rd} and 25^{th} percentile at post-test). These results are similar to those reported within the literature, where some children with ASD scored lower on measures of nonword tasks than real word tasks (Nation, et al., 2006). This suggests that children with ASD who also demonstrate phonological impairments may have difficulty with nonword reading tasks, as seen in children with reading disabilities (Melby-Lervåg et al., 2012).

The results of the present study contribute to the current discussion in the literature on word versus nonword tasks: the participant demonstrated both poor nonword segmenting and strong nonword blending skills. At post-test, the current participant scored within the 2nd percentile on measures of segmenting nonwords, yet scored above the mean on measures of nonword blending (63rd percentile).

This finding is particularly interesting, as the high nonword blending score could indicate hyperlexic tendencies, however the poor segmenting nonword score could be a typical result for a child with ASD and reading difficulties. One possible explanation for the high blending nonword subtest could be because the HeadSprout program incorporated several blending, and a few blending nonword activities, which the participant found particularly enjoyable. It is possible the participant could have transferred his ability to blend word skills to nonwords over the course of the 9 week reading program. The lack of instruction to segmenting activities, especially nonword segmenting activities, could also explain this difference in nonword early reading achievement. The participant's low post-test score on segmenting nonwords could have been affected by several factors previously mentioned, such as maturation and testing error, or could be a common characteristic of a child with poor reading skills (Melby-Lervåg et al., 2012). Future research should examine and compare word and nonword early reading and phonological awareness skills for children with ASD. This will enable researchers and teachers to design effective reading programs for students with ASD.

2. How does the child engage with HeadSprout Early Reading?

Overall, the findings indicate that the HeadSprout Early Reading computer program was particularly engaging for one participant with ASD.

Momentary Time Sampling data indicated that the participant was engaged with the computer lesson an average of 94.5% of the time, and off-task 5.5% of the time. While off-task,

the participant did not appear to be engaged in one specific type of off-task behaviour more than another, but rather engaged in a mix of off-task behaviours: motor (1.1%), vocal (2.2%), and passive (2.3%). Interval-by-interval Interobserver agreement (IOA) confirmed reliability in these results, reporting an average agreement of 90.4% (range 85.2% to 96.4%) between observers for 37% for all program sessions (Cooper et al., 2007).

Engagement findings obtained from the Perceived Participant Engagement method were similar to those obtained from the momentary time sampling**.** Perceived findings indicated that 22 of 27 program sessions scored an average rating of 5, indicating that the participant appeared to be on-task 80% or more of the time. The overall perceived engagement scored a mean rating of 4.98, indicating that the participant was engaged 60% or more of the time. Examined with the Momentary Time Sampling data, these findings suggest that the participant was engaged with the HeadSprout Program a substantially high percent of the time.

These findings are particularly interesting as no research to date has examined engagement with children with ASD using the HeadSprout program. Looking to other research on engagement with children with ASD may provide a benchmark for comparison. Carnahan, Basham, and Musti-Rao (2009) reported that student engagement with interactive books and music during small group instruction reached an average 81% across 6 participants with ASD. Baroody and Diamond (2014) reported similar results, where 158 TD students were engaged an average of 83.8% (range 0% to 100%) during large-group literacy instruction. Together, these findings suggest that children with and without ASD are engaged with instruction more than 80% of the time. In comparison with these related percent engagement findings, the results of the present study demonstrate the effectiveness of HeadSprout in grasping and maintaining the engagement of a user with ASD at substantially high rates.

There is however, a limitation to the Momentary Time Sampling technique and these results should therefore be interpreted with caution. Cooper, et al. (2007) report that Momentary

Time Sampling procedures are best used with "continuous activity behaviours such as engagement with a task… [and] is not recommended for measuring low-frequency, short duration behaviours" (p. 93). This suggests that this procedure can accurately measure engagement however may over- and underestimate low frequency or duration behaviours, such as off-task behaviours. Since this research project examined three off-task behaviours which often occurred for short durations of time, the momentary time sampling method may have missed these behaviours because the observation period was so brief therefore underestimating the occurrence of off-task behaviours. As a result, this measurement method may not have accurately reflected the full reality of participant engagement specifically when the participant was off-task. Researchers suggest keeping the interval length very short (in this project 15 seconds) to prevent this limitation, and strive to reflect the truest form of engagement and off-task behaviours (Cooper, Heron, & Heward, 2007). These findings should therefore be interpreted with caution as they may over-or underestimate the total percent engagement and off-task behaviours observed within each HeadSprout computer lesson.

The results of the Interval-by-Interval Interobserver Agreement method should also be interpreted with caution. The overall IOA method overestimates the agreement between observed behaviours that occur at very low rates. According to Cooper, et al. (2007), this method may not be the most appropriate to measure the agreement for all four of the target behaviours and may overestimate agreement. For example, the overall Interval-by-Interval IOA may be 80% or higher, however the agreement for motor off-task behaviour for example, may be well below 80%. Future research should consider extensive observer training and use unscored- or scored- interval IOA to calculate agreement among observers across all target behaviours, rather than overall. This will ensure a more sensitive estimate of observer agreement and increase the reliability and validity of IOA and the momentary time sampling measures.

Qualitative Reflections on Engagement.

Qualitative data provided significant insight as to why the participant appeared to be engaged. As discussed in Chapter 4, several factors may have contributed to high participant engagement. First, simplicity of instructions may have contributed to high levels of participant engagement. Specifically, children with ASD or ADHD who may have difficulty paying attention, the simple, straight forward, repetitive and consistent framework of the HeadSprout program helped take the guesswork out of what the participant was supposed to do, and enabled him to focus on learning the skills (Mineo, et al., 2009).

Second, the HeadSprout program scaffolds nicely to the child's needs based on the errors to ensure that instruction is not too hard or too easy. Research by Guthrie, et al. (2013) indicated that undermining motivation including perceived difficulty was significantly correlated with avoidance behaviours of TD readers in grade 7. This suggests that students who experience difficulty with academic material are more likely to avoid academic tasks and thus be less engaged. Stemming from Guthrie et al.'s (2013) research, the qualitative findings from the current study suggest that appropriate level of scaffolding ensured the instruction was not too difficult for the participant. As the program was not too difficult, the participant did not to avoid the computer program, and correspondingly was engaged.

Third, visual cues and reinforcement appeared to contribute to student engagement. The visual task completion reminders along with visual and auditory reinforcement systems built into the HeadSprout program engaged the participant through activities and motivated him to complete the task. Mineo et al., (2009) reported similar findings, where the screen engagement of students with ASD was increased when a change in the audio or video occurred. This suggests that auditory and visual components incorporated within the HeadSprout program may have aided in participant engagement.

Fourth, the high variety of activity and trials within the HeadSprout program may have

assisted in participant engagement. Across 27 program sessions, the participant was exposed to an average of 30 minutes 28 seconds of HeadSprout Early Reading computer programming (range 23 to 37 minutes and 45 seconds). During this short period of time, the participant completed an average of 17.18 activities per session (range 10 to 30). Perhaps the exposure to such a high variety of activities kept the participant interested and engaged with the program. An analysis was also conducted to examine the participant's engagement with different types of activities. This revealed that the participant was engaged with the computer activities at an average rating of 4.99 (range 4 to 5). Since the participant was engaged 80% or more of the time with eight of the twelve activity types within the HeadSprout program, it can be concluded that both the type and number of activities within the HeadSprout program contributed to high participant engagement within the computer lessons. The program was also successful in providing a high number of trials within an activity by incorporating animations and music in between to maintain participant engagement.

Participant engagement, as measured through momentary time sampling, perceived participant engagement, and qualitative field notes, suggests that the HeadSprout program engaged the participant. The high variety of activities, clear and simple instructions, careful scaffolding and use of visual and auditory reinforcement appeared to contribute to participant engagement with the HeadSprout program.

3. Is HeadSprout Early Reading an enjoyable reading activity for a child with ASD?

Results indicate that overall the HeadSprout Early Reading was an enjoyable activity for a participant with ASD. Three sources of data help inform this conclusion: participant self-rating of enjoyment, perceived participant enjoyment, and qualitative field notes.

Participant Self-Rating of Enjoyment.

Results from the participant's self-rating of enjoyment were surprising because the

participant assigned a rating of 4 stars to all program sessions indicating he liked the computer program. It became apparent after the first few sessions that the rating activity had become a routine, with a routine enjoyment rating of 4. Despite this self-rating method being simple to use and concrete in defining enjoyment, this method was limited in that the participant was perhaps not able to accurately express his enjoyment of the program through this system.

Researcher observations and qualitative data suggested that this method might be limited as it may underestimate the participant's true enjoyment of the program. Furthermore, despite the participant being able to recite what each of the star ratings represented, this method may have been too abstract for the participant to internalize. Perhaps in the future more information could be collected about the participant prior to using this self-rating of enjoyment method, or the procedure could be altered or modified to allow for description of enjoyment of the program and ensure the participant could accurately rate his or her enjoyment.

Perceived Participant Enjoyment.

The perceived enjoyment and qualitative reflections appeared to provide a better insight into the participant's enjoyment of the HeadSprout program. Results indicated that the participant was perceived to enjoy the HeadSprout program an average rating of 4.89 across all sessions, indicating that the participant loved the activities within the program and would likely want to complete the activity again in the future.

Data in Figure 6 suggests that as the participant became more familiar with the program (after session 10) he also appeared to be more consistent in his enjoyment of the program. This increased stability in enjoyment ratings after session 10 could possibly be explained by the participant's possible comfort with using the HeadSprout program. It is also possible that the participant's observed enjoyment became more consistent later on in the program because he was exposed to more activities; during the first 9 sessions the participant was exposed to fewer activities (average of 13.8 activities per session) than during sessions 10 to 27 (average of 18.8

activities per session). The participant could have found the wider variety of activities after session 10 to be more enjoyable than the first 9 sessions.

Analysis of perceived enjoyment across activities also revealed that the participant enjoyed the majority of activities within the HeadSprout programming. Three of eight activities were scored with an average rating less than 5, yet still indicating the participant was perceived to like the activity.

The findings from the current study provide interesting implications for the reading outcomes of children with ASD. Several researchers have found that typically developing children who enjoy reading activities, are more engaged in reading activities, and have better reading comprehension scores than those who show low interest and enjoyment in reading text (De Naeghle, et al. 2012; Jones & Brown, 2011). These results suggest that the high perceived enjoyment of the participant within the present study may have therefore contributed to the participant's engagement with the program, and possibly positive reading outcomes.

Qualitative Reflections on Participant Enjoyment.

Participant enjoyment was also described qualitatively through researcher observation notes and participant responses to questions following the self-rating of enjoyment activity. As discussed in Chapter 4, several themes emerged indicating why the participant appeared to enjoy the HeadSprout program.

The participant often described that he liked the auditory components of and the animations and characters within the HeadSprout program. HeadSprout Early Reading may have been particularly enjoyable for this participant because of the inclusion of these components throughout the computer program. Layng, Twyman, and Stikeleather (2004) mention that vocal praise, sounds, short cartoon movies are utilized to make the program enjoyable. For the participant in the present study, incorporating characters, short animations, song and vocal praise appeared to motivate him to complete an activity; he knew that an enjoyable and interesting song

or animation would appear after activity completion.

The HeadSprout virtual words and episode map also appeared to be enjoyable aspects of the HeadSprout program for this participant. Specifically using the HeadSprout map helped to foster enjoyment of the HeadSprout program, as the participant could look ahead to see which adventures he would experience next. This episode map not only permitted the participant to mark down his accomplishments by placing stickers over the completed map, but also to look forward to the next episodes and adventures he would explore with the program.

The participant's enjoyment of the verbal feedback used throughout the HeadSprout program was also problematic when he made mistakes. Similar findings were reported by Grindle et al. (2013) where the frequency of a participant's errors increased due to the seeming preference for auditory feedback provided by the HeadSprout program. In designing a reading intervention for any student, one must consider whether the auditory feedback from the program impedes attainment of the goal of the activity since this may not be helping the student to learn.

The participant's overall enjoyment when using the HeadSprout program may have positive implications for engagement and reading outcomes. Similar positive results were reported by Huffstetter et al. (2010), where teacher's believed their students loved and were excited about using the HeadSprout program because it made reading "fun." The ability of the HeadSprout program to be both enjoyable and engaging is also possibly related to positive increases in phonological awareness skills. Jones and Brown (2011) for example, found that capturing students' interest in reading activities promoted enjoyment with the activities, and increased the likelihood of scoring higher on measures of reading comprehension. This suggests that the HeadSprout program is therefore not only engaging and enjoyable to the user, but may also produce increases on a variety of reading outcomes (Grindle et al., 2013; Huffstetter, et al., 2010; Twyman, et al., 2011; Whitcomb, et al., 2011).

Implications for Practice

An Interrelated Relationship: Assistance, Engagement, and Enjoyment.

A careful examination of the data revealed that the HeadSprout Early Reading program could have been successful for this participant because of the delicate balance among three important and interrelated factors in student learning: level of assistance required, participant engagement and participant enjoyment.

As demonstrated in Figure 9, the average perceived level of assistance is almost always below the trend of perceived enjoyment. This indicates that when the student is experiencing less difficulty with an activity, he is likely enjoying the activity more, or when a student experiences more difficulty and requires more assistance with an activity, he is likely to enjoy the activity less. Guthrie et al. (2013) reported similar findings, where students who experience difficulty with academic material are more likely to avoid academic tasks and thus are less engaged.

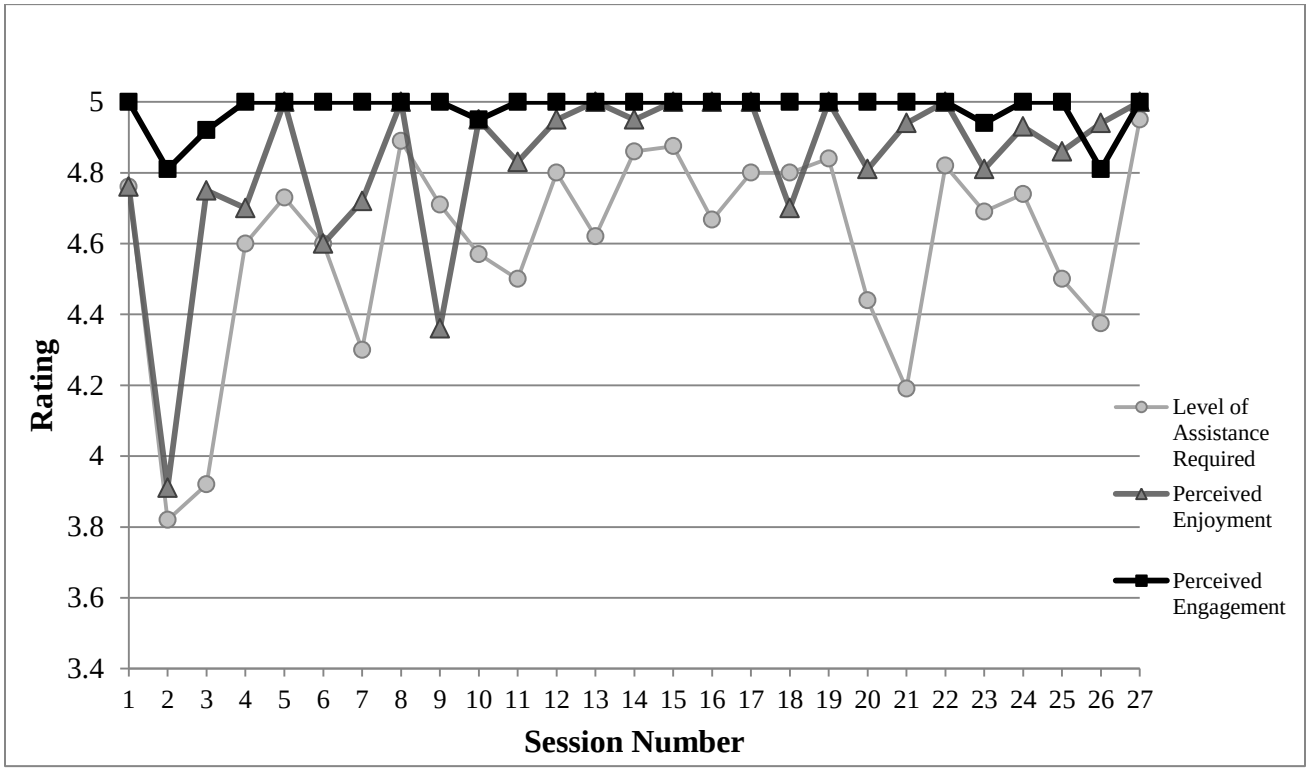


Figure 9. *Average Perceived Daily Rating per Session.*

This figure also demonstrates a possible relationship between enjoyment and engagement for the participant: on session two for example, data revealed a low perceived rating of enjoyment and a low rating of level assistance (meaning more help was required). This suggests that when students are trying to complete activities that are hard for them, they are likely to be enjoying the activity less and therefore less engaged. Intuitively this makes sense, as the less enjoyable an activity is, the less engaged you may be. Collectively, these findings suggest that these three concepts are inter-related and each has important implications for student learning. Specifically, educators should scaffold their lessons to an appropriate level of difficulty to ensure that students are enjoying and are engaged with the lesson. Ensuring activities are at an appropriate level of difficulty for each individual child helps to make the learning fun and enjoyable for students, and allows for responsibility and skill independence to transfer to the students (Shaffer, Wood & Willoughby, 2005). Future research should therefore examine the

direction of the relationship between engagement, enjoyment and task difficulty or level of assistance required, in addition to reading outcomes for children with ASD and children at risk for reading difficulties. Results could be used to inform practitioners in the field of learning and education.

Get to know your students.

An important lesson learned from this research project provides powerful information to parents, teachers, and therapists: know your student. To keep them interested and engaged with learning, parents, teachers, and therapists should know each individual student's learning patterns, specific areas of difficulty and strengths, what they enjoy, and what can help to keep them engaged. Knowing this information and each of your students, you will be able to predict which specific activities may be problematic and proactively scaffold your assistance to maximize engagement and learning. For example, with the current study's participant, understanding the enjoyment of verbal feedback as a motivator and specific activities that may be problematic were useful strategies in knowing when and how much assistance and praise to provide to the student to ensure learning success and enjoyment during the lessons. Instruction, scaffolded support, and reinforcement can then be adjusted to reinforce students for appropriate behaviour, and to set up the conditions for optimal learning (Shaffer, et al., 2005).

Build a Routine.

Several researchers have noted the importance of schedule routines for students with ASD (Hart & Whalon, 2008; HeadSprout 2008; Layng, et al. 2004; Ontario Ministry of Education, 2005). A simple way to incorporate learning routines into one-to-one instruction is by using a whiteboard to represent the session schedule (Goodman & Williams, 2007). This was specifically effective in making the reading program's schedule a routine and helped to prevent the participant from walking around after the computer activity was complete. Building a routine for academic programs or schedules in this way helped maximize student engagement

and limit distraction or concern about what is to come; rather it helped to create a common set of expectations for the learning environment.

Be Proactive: Identify Sources of Reinforcement for Participant Responding during Challenging Activities.

Educators should be particularly aware and constantly observing their students to identify possible activities or behaviours that could interfere with learning. If educators can identify problem activities or behaviours before they get reinforced, educational gains can be maximized. For example, making note early on which activities a student may intentionally make errors in, can be useful for practitioners to intervene early and support student learning and success. As part of this, instructors should also be proactive in identifying actions or statements that could reinforce a child's errors or problematic responding. In the present study for example, the participant found the vocal feedback after responding incorrectly particularly reinforcing. He would therefore make intentional errors in order to hear the vocal feedback, such as "that's not it" (Learning A-Z, 2014). Similar findings were reported by Grindle et al. (2013) where the frequency of a participant's errors increased potentially due to the seeming preference for auditory feedback provided by the HeadSprout program.

To prevent these situations parents, teachers and therapists should be proactive in identifying challenging activities, or find a powerful reinforcer that can be used to motivate the student to complete the activity correctly. For example, some children may find it reinforcing to have an adult draw attention to their errors. In this research project, it became clear that the participant enjoyed negative feedback and therefore would respond to elicit this negative feedback: because the participant liked to hear "strike one" in baseball for example, he would therefore not try to hit the ball because he wanted to hear "strike two." As a result, parents, teachers, and therapists must be cognisant of their actions to ensure they are not reinforcing problem behaviour. Rather, by not drawing any attention to errors for this student (for example,

not saying “nice try” and prompting the correct response) and providing feedback, praise or other reinforcement for appropriate responses, the problem behaviour or responding can be reduced or eliminated. Potential challenging activities or possible reinforcers for problematic responding need to be identified, so that instruction and reinforcement can be adapted to ensure appropriate responding and positive behaviours.

Be Proactive: Assess your Child’s Energy, Attentiveness, and Distractibility.

All educators know that each child’s level of attention, energy, and enthusiasm vary from day to day; some days students will be focused with sustained attention, while other days students may be quiet, distracted, fidgety, and find it difficult to sit still. It is important that parents, teachers, and support staff adjust their expectations for lesson learning based on these observations. For example, it will likely not be productive to sit a child down to focus for long periods of time if the child is very impulsive, is very distracted and has high energy during that time. Therefore, educators should adjust the lesson’s expectations in accordance with these observations, in addition to scaffolding their support level based on the student’s energy, attentiveness, and distractibility. On days when the child has high energy and is more easily distracted, more support may be required to maximize learning and minimize mistakes. As part of this, educators should be sensitive to their child’s needs and know when they should pause programming and give the child a break or resume a lesson at a later point in the day. Especially when working with students with ASD and/or ADHD, maximizing student engagement is essential to consider to ensure students are learning.

Student energy, attentiveness, and distractibility should also be considered in planning instruction, and extra book reading and flashcards time, to effectively maximize engagement. Observational data from this research project also noted that utilizing the flashcards right after the lesson may be too taxing on the participant’s attention. Parents, teachers and educators should consider their student’s needs when deciding if additional practice in the area of difficulty

should be undertaken after completing the HeadSprout lesson, or if it would be more beneficial to use the flashcards at a different time of the day. By observing students and adjusting instruction to their daily needs, attention and engagement with lessons can be maximized, consequently contributing to optimal learning.

Consider Most-to-Least Prompting.

The type of prompting procedure used during instruction may vary depending on the student. For the participant in the current study, a vocal prompt to "wait and look" during activities with an array of responses was an effective strategy; others may need more or less intrusive prompting to ensure success in responding. By building a routine for prompting, positive learning opportunities are established for students to become more independent in acquiring skills.

Researchers have discussed the utility of different prompting strategies depending on the level of skill of the participant (Cooper et al., 2007). Qualitative results from this study found that during new or harder activities, a most-to-least prompting procedure was more effective in building successes for the participant. For example, by prompting the student to keep hands back from the mouse, look at each option, tell the adult, before selecting the answer, the student learned to look at all the options before answering (appropriate behaviour) which also helped to prevent impulsive responding (which often leads to errors). Therefore, for this participant, a most-to-least prompting strategy was most effective when learning a new skill or trying out a new activity. Consistent with suggestions by Cooper et al., (2007), most-to-least prompting should be used when individuals are likely to make an incorrect response, or when exposed to novel stimuli, as it is a proactive strategy to build the participant's confidence and correct responding. As a child becomes successful and more independent in correct responding, a least-to most prompting strategy would be more effective (Cooper et al., 2007).

Include a High Number of Short Duration Activities within Instruction.

Results of the current study suggest that incorporating a high number of short activities within a lesson, as found in the HeadSprout program, may help to maximize engagement of students who may experience difficulty attending to longer periods of instruction within the classroom. Including shorter activities that are enjoyable and interesting to the child, may maximize student engagement and learning, and allow for frequent access to reinforcement.

Address Challenges during One-to-One Teaching Periods.

If an instruction period or activity is too long or too complex for a student, educators might try to break it down and incorporate periods of focused teaching. Within this research project for example, on the 11th session the HeadSprout program introduced 3 new sounds without providing sufficient time and exposure to each sound. The participant became somewhat overwhelmed and made several errors when the program asked him to complete more complex activities without having previously mastered each of the sounds he had just learned.

Proactive and responsive educators should ensure their students understand and master each skill independently before introducing them to new skills. By stopping the activity and providing more intensive teaching for each of these sounds before moving on to more complex activities, students can be set up for success (Grindle, et al., 2013). HeadSprout attempts to set up these opportunities through use of the word flashcards that complement the HeadSprout Early Reading lessons. These flashcards could be used in a strategic way to focus on and teach the student words and sounds that trouble him or her. For example, an educator could make note of the difficult words or sounds for the student within the computer lesson and then target these sounds with flashcards later in the day.

Future research should consider incorporating flashcards and daily data collection, to address a student's challenges and ensure that the student masters all sounds and words. For example, Grindle et al. (2013) found additional discrete trial teaching to be effective in

remediating problems encountered throughout the HeadSprout lessons. Weekly maintenance checks could also be incorporated into program sessions to ensure the student is maintaining skill in previous trouble sounds and words. By incorporating aspects of daily data collection and targeted individualized practice with the technique of discrete trial teaching, educators may maximize student engagement and correct responding, ensuring students master each foundational skill independently before being introduced to new skills.

Limitations

The sample size is the largest limitation of this research project as the results cannot be generalized to other children with ASD. To strengthen the external validity of this study, future researchers should increase the number of participants, include both female and male participants, incorporate some type of intelligence quotient (IQ) or Autism symptom severity rating scale, and increase the geographical scope or location of participants.

The second general limitation to this research project is related to the reliability, validity, and ability to replicate the perceived enjoyment and engagement measures. These findings are simply the observations and opinions of the primary researcher and may not be reliably replicated by other researchers. To improve upon this limitation in the future, researchers could include a second observer into each program session to collect data at the same time as the primary researcher, and calculate interobserver agreement to ensure reliable and valid observation results. This method may have issues with participant reactivity, however the results could be considered reliable and valid, making the study easier to replicate.

A third limitation to this research project is the pre-mid-post design. In the future, using a single subject design with repeated measures could have provided sufficient evidence for specific reading skills. For example, by including a daily measurement of specific reading skills, the design could have supported and strengthened the argument that HeadSprout Early reading fostered the development of specific reading skills, not just phonological awareness. The current

pre-mid-post design may not have been sensitive enough to detect progress across a variety of reading skills for the individual student, and by incorporating repeated measures into the single-subject design the study may have strengthened the practical implications of its findings (Engel & Schutt, 2009).

A fourth limitation was the absence of interobserver agreement (IOA) for treatment integrity measures. Self-report measures, such as this measure of treatment integrity, are indirect measuring tools. This limits the ability for researchers to establish confidence regarding reliability of their results (Cooper, et al., 2007). The absence of IOA calculations for treatment integrity within this study, limit the researcher's confidence that the average integrity findings are reliable. Future research projects should consider calculating IOA for all measurement tools.

Conclusion

The results from this study provide evidence that following a 9 week reading program using HeadSprout Early Reading, one participant with ASD demonstrated considerable gains on four of five subtests of phonological awareness. This suggests that using HeadSprout Early Reading was effective in supporting the acquisition of elision, blending words, blending nonwords and segmenting word skills for this participant. These findings also indicate that more explicit instruction of segmenting nonwords may produce more robust results for the segmenting nonword subtest and perhaps segmenting skills may just be beginning to emerge, and will continue to increase as a product of maturation. A high percentage of participant engagement and participant enjoyment was found which may have been due to the unique structure and framework of the HeadSprout program. The music, fun characters and animations, in addition to the simple and scaffolded instructions appeared to make HeadSprout an engaging and enjoyable reading program when used with adult supervision. Sample size and scope of reading measures are two general limitations to this study. Similar research should be conducted with a larger and more varied sample to generalize the findings to a larger scope of children with ASD. Future

research should also examine the relationship between level of assistance, engagement, and enjoyment with childrens' educational outcomes.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). Arlington: American Psychiatric Publishing.

Asberg, J., & Dahlgren Sandberg, A. (2012). Dyslexic, delayed, precocious, or just normal? Word reading skills of children with Autism Spectrum Disorders. *Journal of Research in Reading, 35*(1), 20-31. doi:10.1111/j.1467-9817.2010.01452.x

Asberg, J., Dahlgren, S., & Dahlgren Sandberg, A. (2008). Basic reading skills in high-functioning Swedish children with autism spectrum disorders or attention disorder. *Research in Autism Spectrum Disorders, 2*, 95-109. doi:10.1016/j.rasd.2007.03.006

Baroody, A. E., & Diamond, K. E. (2014, May 1). Associations among preschool children's literacy environment, interest, and engagement in literacy activities, and early reading skills. *Journal of Early Childhood Research*, 1-17. doi:10.1177/1476718X14529280

Bender, W. N. (2008). *Learning Disabilities: Characteristics, identification, and teaching strategies* (6th ed.). (V. Lanigan, Ed.) Toronto: Pearson: Allyn and Bacon.

Bryson, S. A., Corrigan, S. K., McDonald, T. P., & Holmes, C. (2008). Characteristics of children with autism spectrum disorders who received services through community mental health centers. *The National Autistic Society, 12*(1), 65-82. doi:10.1177/1362361307085214

Calhoon, J. A. (2001). Factors affecting the reading of rimes in words and nonwords in beginning readers with cognitive disabilities and typically developing readers: Explorations in similarity and difference in word recognition cue use. *Journal of Autism and Developmental Disorders, 31*(5), 491- 504.

Carnahan, C., Basham, J., & Musti-Rao, S. (2009). A low-technology strategy for increasing engagement of students with Autism and significant learning needs. *Exceptionality, 17*, 76-87. doi:10.1080/09362830902805798

Castles, A., & Coltheart, M. (2004). Is there a causal link from phonological awareness to success in learning to read? *Cognition, 91*, 77-111. doi:10.1016/S0010-0277(03)00164-1

Centre for Disease Control and Prevention. (2012). Prevalence of Autism Spectrum Disorders - Autism and Developmental Disabilities Monitoring Network, 14 Sites, United States of America, 2008. *Surveillance Summaries, 61*(3), 1-19.

Christine, D., & Christine, C. (1964). The relationship of auditory discrimination to articulatory defects and reading retardation. *The Elementary School Journal, 65*(2), 97-100.

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). *Applied Behavior Analysis* (2nd ed.). New Jersey: Pearson: Merrill Prentice Hall.

Davidson, M. M., & Weismer, S. E. (2014). Characterization and prediction of early reading abilities in children on the Autism Spectrum. *Journal of Autism and Developmental Disorders, 44*, 828-845.

De Naeghle, J., Van Keer, H., Vansteenskiste, M., & Posseel, Y. (2012). The relation between elementary students' recreational and academic reading motivation, reading frequency, engagement, and comprehension: A self-determination theory perspective. *Journal of Educational Psychology, 104*(4), 1006-1021. doi:10.1037/a0027800

Dumas, J. E., & Nilsen, W. J. (2003). *Abnormal child and adolescent psychology.* Toronto: Pearson Education, Inc.: Allyn and Bacon.

Engel, R. J., & Schutt, R. K. (2009). Single-subject design. In R. J. Engel, & R. K. Schutt, *The Practice of Research in Social Work* (pp. 206-246). Thousand Oaks: Sage Publications, Inc.

Goodman, G., & Williams, C. M. (2007). Interventions for increasing academic engagement of students with Autism Spectrum Disorders in inclusive classrooms. *Teaching Exceptional Children, 39*(6), 53-61.

Government of Canada. (2008, December 1). *Literacy counts*. Retrieved November 16, 2012, from Statistics Canada: http://www.statcan.gc.ca/pub/81-004-x/200404/6853-eng.htm

Gray, A., & McCutchen, D. (2006, August). Young readers' use of phonological information: Phonological awareness, memory, and comprehension. *Journal of Learning Disabilities, 39*(4), 325 - 333.

Grigorenko, E. L., Klin, A., & Volkmar, F. (2003). Annotation: Hyperlexia: disability or super ability? *Journal of Child Psychology and Psychiatry, 44*(8), 1079-1091.

Grindle, C. F., Hughes, J. C., Saville, M., Huxley, K., & Hastings, R. P. (2013). Teaching early reading skills to children with Autism using HeadSprout Early Reading. *Behavioural Interventions, 28*(3), 203–224. doi:10.1002/bin.1364

Guthrie, J. T., Klauda, S. L., & Ho, A. N. (2013). Modeling the relationships among reading instruction, motivation, engagement, and achievement for adolescents. *Reading Research Quarterly, 48*(1), 9-26. doi:10.1002/rrq.035

Guthrie, J. T., Wigfield, A., & You, W. (2012). Instructional Contexts for Engagement and Achievement in Reading. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.), *Handbook of Research on Student Engagement* (pp. 601-634). New York: Springer. doi:DOI 10.1007/978-1-4614-2018-7_29

Harding, J. (2013). *Qualitative data analysis: From start to finish.* Washington: Sage Publications Inc.

HeadSprout. (2008). Building frequency in HeadSprout Early Reading: Strategies and tactics implementation guide. United States of America: HeadSprout, Inc.

HeadSprout Early Reading. (2011). *Episode summary: Overview of sounds, words, skills, and strategies covered by episode.* Montreal: Mimio Interactive Teaching Technologies.

Heimann, M., Nelson, K. E., Tjus, T., & Gillberg, C. (1995). Increasing reading and communication skills in children with Autism through an interactive multimedia computer program. *Journal of Autism and Developmental Disorders, 25*(5), 459-478.

Hintze, J. M., Ryan, A. L., & Stoner, G. (2003). Concurrent validity and diagnostic accuracy of the Dynamic Indicators of Basic Early Literacy Skills and the comprehensive test of phonological processing. *School Psychology Review, 32*(4), 541-556.

Hogan, T. P., Catts, H. W., & Little, T. D. (2005). The relationship between phonological awareness and reading: Implications for the assessment of phonological awareness. *Language, Speech and Hearing Services in Schools, 36*(4), 285 - 351. doi:0161.1461/05/3604-0285

Hooper, S. R., Poon, K. K., Marcus, L., & Fine, C. (2006). Neuropsychological characteristics of school-aged children with high-functioning Autism: Performance on the NEPSY. *Child Neuropsychology, 12*, 299-305. doi:10.1080/09297040600737984

Huemer, S. V., & Mann, V. (2010). A comprehensive profile of decoding and comprehension in Autism Spectrum Disorders. *Journal of Autism and Development Disorders, 40*, 485-493. doi:10.1007/s10803-009-0892-3

Huffstetter, M., King, J. R., Onwuegbuzie, A. J., Schneider, J. J., & Powell-Smith, K. A. (2010). Effects of a computer-based early reading program on the early reading and oral language skills of at-risk preschool children. *Journal of education for Students Placed at Risk, 15*, 279-298. doi:10.1080/10824669.2010.532415

Jacobs, D. W., & Richdale, A. L. (2013). Predicting literacy in children with a high-functioning Autism Spectrum Disorder. *Research in Developmental Disabilities, 34*, 2379-2390. doi:10.1016/j.ridd.2013.04.007

Jones, T., & Brown, C. (2011). Reading engagement: A comparison between e-books and traditional print books in an elementary classroom. *International Journal of Instruction, 4*(2), 5-19.

Kamps, D., Walker, D., Locke, P., & Delquadri, J. (1990). A comparison of instructional arrangements for children with Autism served in a public school setting. *Education and Treatment of Children, 13*(3), 197-215.

Kozlowski, A. M., Matson, J. L., & Belva, B. C. (2012). Social skills differences between the Autism Spectrum Disorders. *Journal of Developmental and Physical Disabilities, 24*, 125-134. doi:10.1007/s10882-011-9260-2

Ladd, G. W., & Dinella, L. M. (2009). Continuity and change in early school engagement: Predictive of children's achievement trajectories from first to eighth grade? *Journal of Educational Psychology, 101*(1), 190-206. doi:10.1037/a0013153

Lanter, E., Watson, L. R., Erickson, K. A., & Freeman, D. (2012). Emergent literacy in children with Autism: An exploration of developmental and contextual dynamic processes. *Language, Speech, and Heading Services in Schools, 43*, 308-324.

Layng, T. V., Twyman, J. S., & Stikeleather, G. (2004). Selected for success: How HeadSprout Reading Basics TM teaches children to read. In D. J. Moran, & R. Malott (Eds.), *Evidence-Based Education Methods* (pp. 171-197). St. Louis: Elsevier Science/Academic Press.

Leaf, J. B., Tsuji, K. H., Lentell, A. E., Dale, S. E., Kassardjian, A., Taubman, M., . . . Oppenheim-Leaf, M. L. (2013). A comparison of discrete trial teaching implemented in a one-to-one instructional format and in a group instructional format. *Behavioural Interventions, 28*, 82-106. doi:10.1002/bn.1357

Learning A-Z. (2014, June 13). *HeadSprout Member Login.* Retrieved from HeadSprout.com: http://www.headsprout.com/

Lemons, C. J., & Fuchs, D. (2010). Phonological awareness of children with Down Syndrome: Its role in learning to read and the effectiveness of related interventions. *Research in Developmental Disabilities, 31*, 316-330.

Lennon, J., & Slesinski, C. (2001). Comprehensive Test of Phonological Processing (CTOPP): Cognitive linguistic assessment of severe reading problems. *NASP Communique, 29*(9).

Lonigan, C. J., Purpura, D. J., Wilson, S. B., Walker, P. M., & Clancy-Menchetti, J. (2013). Evaluating the components of an emergent literacy intervention for preschool children at risk for reading difficulties. *Journal of Experimental Child Psychology, 114*, 111-130. doi:10.1016/j.jecp.2012.08.010

Lunsky, Y., Lake, J. K., Balogh, R., Weiss, J., & Morris, S. (2013). A review of Canadian mental health research on intellectual and developmental disabilities. *Journal of Mental Health Research in Intellectual Disabilities, 6*, 106-126. doi:10.1080/19315864.2012.700685

MacDonald, C., & Figueredo, L. (2010). Closing the gap early: Implementing a literacy intervention for at-risk kindergarteners in urban schools. *The Reading Teacher, 63*(5), 404-419.

Melby-Lervåg, M., Lyster. , S.-A. H., & Hulme, C. (2012). Phonological skills and their role in learning to read: A meta-analytic review. *Phonological Bulletin, 138*(2), 322-343. doi:10.1037/a0026744

Mineo, B. A., Ziegler, W., Gill, S., & Salkin, D. (2009). Engagement with electronic screen media among students with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders, 39*, 172-187. doi:10.1007/s10802-008-0616-0

Miniscalco, C., & Dahlgren Sandberg, A. (2010). Basic reading skills in Swedish children with late developing language and with or without Autism Spectrum Disorder or ADHD. *Research in Developmental Disabilities, 31*, 1054-1061. doi:110.10116/j.ridd.2010.04.004

Mirenda, P. (2003). "He's Not Really a Reader...": Perspectives on supporting literacy development in individuals with Autism. *Topics in Language Disorders, 23*(4), 271-282.

Nation, K., Clarke, P., Wright, B., & Williams, C. (2006). Patterns of reading ability in children with Autism Spectrum Disorder. *Journal of Autism and Developmental Disorders, 36*, 911-919. doi:10.1007/s10803-006-0130-1.

National Institute of Child Health and Human Development (2000). Report of the National Reading Panel. Teaching children to read: An evidence-based assessment of scientific research literature on reading and its implications for reading instruction (NIH Publication No. 00-4769). Washington, D.C.: U.S. Government Printing Office.

Newman, T. M., Macomber, D., Naples, A. J., Babitz, T., Volkmar, F., & Grigorenko, E. L. (2007). Hyperlexia in children with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders, 37*(4), 760-774.

Norbury, C., & Nation, K. (2011). Understanding variability in reading comprehension in adolescents with Autism Spectrum Disorders: Interactions with language status and decoding skill. *Scientific Studies of Reading, 15*(3), 191-210. doi:10.1080/10888431003623553

O'Connell, T. S., & Dyment, J. E. (2013). *Theory into practice: Unlocking the power and potential of reflective journals.* Charlotte: Information Age Publishing, Inc.

O'Connor, I. M., & Klein, P. D. (2004). Exploration of strategies for facilitating the reading comprehension of high-functioning students with Autism Spectrum Disorders. *Journal of Autism and Developmental Disorders, 34*(2), 115-127.

Ontario Ministry of Education & Ontario Ministry of Children and Youth Services. (2007). *Making a difference for students with autism spectrum disorders in Ontario schools: From evidence to action.* Ministers' Autism Spectrum Disorders Reference Group, Ministry of Education, and Ministry of Children and Youth Services. Toronto: Government of Ontario.

Ontario Ministry of Education. (2005). *Education for all: The Report of the expert panel on literacy and numeracy instruction for students with special education needs, Kindergarten to Grade 6.* Toronto: Ontario Ministry of Education.

Ontario Ministry of Education. (2007). *Effective educational practices for students with Autism Spectrum Disorders.* Ministry of Education. Toronto: Government of Ontario.

Pennington, B. F., & Lefly, D. L. (2001, May/June). Early reading development in children at family risk for Dyslexia. *Child Development, 72*(3), 816-833. doi:10.1111/1467-8624.00317

Pennington, R. C. (2010). Computer-assisted instruction for teaching academic skills to students with Autism Spectrum Disorders: A review of the literature. *Focus on Autism and Other Developmental Disabilities, 25*(4), 239-248. doi:10.1177/1088357610378291

Phillips, B. M., Clancy-Menchetti, J., & Lonigan, C. J. (2008, May). Successful phonological awareness instruction with preschool children. *Topics in Early Childhood Special Education, 28*(1), 3-17. doi:10.1177/0271121407313813

Regents of the University of Minnesota. (2011). *Reading and students with Autism*. Retrieved November 17, 2012, from Partnership for Accessible Reading Assessments: http://www.readingassessment.info/resources/publications/readingandautism.htm

Schuele, C. M., & Boudreau, D. (2008). Phonological awareness intervention: Beyond the basics. *Language, Speech, and Hearing Services in Schools, 39*, 3-20. doi:0161-1461/08/3901-0003

Shaffer, D. R., Wood, E., & Willoughby, T. (2005). *Developmental psychology: Childhood and adolescence* (2nd Canadian ed.). Canada: Thomson Nelson.

Smith Gabig, C. (2010). Phonological awareness and word recognition in reading by children with Autism. *Communication Disorders Quarterly, 31*(2), 67-85. doi:10.1177/1525740108328410

Soltani, A., & Roslan, S. (2013). Contributions of phonological awareness, phonological short-term memory, and rapid automated naming, toward decoding ability in students with mild Intellectual Disability. *Research in Developmental Disabilities, 34*, 1090-1099. doi:10.1016/j.ridd.2012.12.005

Spector, J. E. (2011). Sight word instruction for students with Autism: An evaluation of the evidence base. *Journal of Autism and Developmental Disorders, 41*, 1411-1422. doi:10.1007/s10803-010-1165-x

The Regents of the University of Michigan. (2013). *Teaching phonological awareness*. Retrieved from University of Michigan: Dyslexia Help:

http://dyslexiahelp.umich.edu/professionals/dyslexia-school/phonological-awareness/teaching-phonological-awareness

Tjus, T., Heimann, M., & Nelson, K. (2004). Reading acquisition by implementing a multimedia intervention strategy for fifty children with Autism or other learning and communication disabilities. *Journal of Cognitive and Behavioural Psychotherapies, 4*(2), 203-221.

Torgesen, J. K., Wagner, R. K., Rashotte, C. A., Herron, J., & Lindamood, P. (2010). Computer-assisted instruction to prevent early reading difficulties in students at risk for Dyslexia: Outcomes from two instructional approaches. *Annals of Dyslexia, 60*, 40-56. doi:10.1007/s11881-009-0032-y

Torgesen, J. K., Wagner, R. K., Rashotte, C., Lindamood, R. E., Conway, P., & Garvan, C. (1999). Preventing reading failure in young children with phonological processing Disabilities: Group and individual responses to instruction. *Journal of Educational Psychology, 91*(4), 579-593.

Twyman, J. S., Layng, T. J., & Layng, Z. R. (2011). The likelihood of instructionally beneficial, trivial, or negative results for kindergarten and first grade learners who complete at least half of HeadSprout Early Reading. *Behavioural Technology Today, 6*, 1-19.

Vervake, S. L., McNamara, J. K., & Scissons, M. (2007). Kindergarten screening for Reading Disabilities. *Journal of Applied Research on Learning, 1*(1), 1-19.

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. (M. Cole, V. John-Steiner, S. Scribner, & E. Souberman, Eds.) Cambridge, Massachusetts, United States of America: Harvard University Press.

Wagner, R. K., Torgesen, J. K., & Rashotte, C. A. (1994). Development of reading-related phonological processing abilities: New evidence of bidirectional causality from a latent variable longitudinal study. *Developmental Psychology, 30*(1), 73-87.

Wagner, R., Torgesen, J., & Rashotte, C. (1999). *Comprehensive Test of Phonological Processing.* Austin, Tx: Pro-Ed.

Wepman, J. M. (1960). Auditory discrimination, speech, and reading. *The Elementary School Journal, 60*(6), 325-333.

Wepman, J. M. (1986). Wepman's Auditory Discrimination Test™. *2*. Western Psychological Services.

Whalon, K. J., & Hart, J. E. (2011). Children with Autism Spectrum Disorder and literacy instruction: An exploratory study of elementary inclusive settings. *Remedial and Special Education, 32*(3), 243-255. doi:10.1177/0741932510362174

Whalon, K. J., Al Otaiba, S., & Delano, M. E. (2009). Evidence-based reading instruction for individuals with Autism Spectrum Disorders. *Focus on Autism and Other Developmental Disabilities, 24*(1), 3-16. doi:10.1177/1088357608328515

Whitcomb, S. A., Bass, D. J., & Luiselli, J. K. (2011). Effects of a computer-based early reading program (HeadSprout) on word list and text reading skills in a student with Autism. *Journal of Developmental and Physical Disabilities, 23*, 491-499. doi:10.1007/s10882-011-9240-6

White, S., Frither, U., Milne, E., Rosen, S., Swettenham, J., & Ramus, F. (2006). A double dissociation between sensorimotor impairments and reading disability: A comparison of Autistic and Dyslexic children. *Cognitive Neuropsychology, 23*(5), 748-761.

Williams, C., Wright, B., Callaghan, G., & Coughlan, B. (2002). Do children with Autism learn to read more readily by computer assisted instruction or traditional book methods? A pilot study. *Autism, 6*(1), 71-91.

Yaw, J. S., Skinner, C. H., Parkhurst, J., Taylor, C. M., Booher, J., & Chambers, K. (2011). Extending research on a computer-based sight-word reading intervention to a student with Autism. *Journal of Behavioural Education, 20*, 44-54. doi:10.1007/s10864-010-9118-1

Yopp, H. K., & Yopp, R. H. (2000). Supporting phonemic awareness development in the classroom: Playful and appealing activities that focus on the sound structure of language support literacy development. *The Reading Teacher, 54*(2), 130-143.

Appendix A.

HeadSprout Overview: Instructional Scope

Headsprout EARLY READING

Instructional Scope and Sequence

The following sequence, tested extensively with children, has been found to be very effective in ensuring reading success.

Covered in Episodes	1-5	6-11	12-18	19-23	24-30	31-40
Phonemic Awareness - *Goal: To establish the ability to hear, identify, and manipulate the individual sounds—phonemes—in spoken words*						
Listening to Sounds: phonemes in words	√	√	√	√	√	√
Segmentation: initial, middle, and final phonemes in words	√	√	√	√	√	√
Vocalization and Blending: phonemes, words	√	√	√	√	√	√
Auditory-Visual Matching: phonemes	√	√	√	√	√	√
Listening, Seeing, Responding: phonemes	√	√	√	√	√	√
Vocalization: phonemes	√	√	√	√	√	√
Structured Discovery Learning: phonemes	√	√	√	√	√	√
Phoneme Isolation: recognizing individual sounds in words	√	√	√	√	√	√
Phoneme Identity: recognizing the same sound in different words	√	√	√	√	√	√
Segmentation, Blending, Vocalization, and Identification: phonemes in words	√	√	√	√	√	√
Phonics - *Goal: To establish an understanding of the predictable relationship between phonemes and graphemes*						
Identification: phonemes	√	√	√	√	√	√
Vocalization: phonemes corresponding to graphemes	√	√	√	√	√	√
Blending and Identification: phonemes and words	√	√	√	√	√	√
Vocalization and Blending: phonemes and words	√	√	√	√	√	√
Listening, Seeing, Responding: phonemes and words	√	√	√	√	√	√
Structured Discovery Learning: phonemes corresponding to graphemes	√	√	√	√	√	√
Segmentation, Blending, Vocalization, and Discovery Learning: words		√	√	√	√	√
Segmentation, Blending, Vocalization, and Identification: phonemes and words		√	√	√	√	√
Segmentation, Blending, and Vocalization: nonsense words						√
Fluency - *Goal: To fluently recognize sounds and words, and to accurately and quickly read text*						
Segmentation and Identification: phonemes in words	√	√	√	√	√	√
Identification: words	√	√	√	√	√	√
Fluent Oral Reading (reading without hesitation)ǂ	√	√	√	√	√	√
Vocabulary - *Goal: To establish print and spoken words needed to communicate effectively*						
High-Frequency Words	√	√	√	√	√	√
Picture Selection Vocabularyǂ	√	√	√	√	√	√
Suffixes		√	√	√	√	√
Comparatives and Superlatives						√
Text Comprehension - *Goal: To establish an understanding of what is read*						
Main Idea: sentences	√	√	√	√	√	√
Predicting, introduction of: story ǂ			√	√	√	√
Fluent Oral Reading (Reading with Meaning, Reading with Prosody)ǂ				√	√	√
Print Awareness - *Goal: To become familiar with print and text conventions, and the relationship between spoken and printed language*						
Left-to-right, Top-to-bottomǂ	√	√	√	√	√	√
Picture/Text Relationshipǂ	√	√	√	√	√	√
Capitalization		√	√	√	√	√
Font "Generalization"				√	√	√
End Punctuation				√	√	√
Quotation Marks					√	√

ǂMany of these skills and strategies are also carried over in specific enrichment activities that accompany the online instruction.

Headsprout EARLY READING

Episode Summary

Overview of Sounds, Words, Skills and Strategies Covered by Episode

Episode	Featured Sounds & Sight Words®	Skills & Strategies
1	s, ee, see	establishing, segmenting, blending, decoding
2	v, an, n	establishing, segmenting
3	s, ee, v, an, see	establishing, blending, decoding
4	s, ee, v, an, see, the	decoding, word reading, establishing, punctuation
5	s, ee, v, an, see, the	decoding, word reading, story reading, reading comprehension
6	cl, c, l, n	establishing, segmenting
7	cl, c, l, ee, an, n	segmenting, blending, capitalization, decoding, word reading, establishing
8	fr, f, r, fl, cr, sl, sn	establishing, segmenting
9	fl, sl, fr, an, f, ee, l, s	segmenting, blending, decoding, capitalization, word reading
10	f, an, r, fr, fl, cr, cl	blending, decoding, word reading, sound production firming
11	s, ee, r, l, c, an, fl	blending, decoding, punctuation, sentence reading, story reading, reading comprehension
12	and[kk], I, out[kk], see	establishing, word reading, sentence reading, reading comprehension
13	ip, p, pl, pr, sp	establishing, segmenting
14	fl, ip, s, sl, ee, p	blending, decoding, capitalization, word reading
15	cl, ip, s, p, ee, sl, fl, pl	blending, word reading, establishing, punctuation
16	cl, ee, pl, an, r, f, l, ip, s	capitalization, decoding, word reading
17	ip, p, pr, cl, ee, r, f, l	establishing, blending, decoding, word reading
18	sl, ip, s, p, ee, l, fr, the, I, and, see	blending, decoding, sentence reading, story reading, reading comprehension
19	ish, sh, c, ip	establishing, segmenting, sound production firming
20	ip, c, sh, ish, f, sl, ee, p, s	segmenting, blending, decoding, punctuation
21	sh, s, ish, r, f	decoding, word reading, segmenting
22	v, an, ish, sh, ee, p, ip, s, r, f, l	blending, decoding, word reading
23	cl, I, ee, f, s, the, see, and	segmenting, blending, decoding, punctuation, sentence reading, story reading, reading comprehension

Headsprout®

now part of DYMO | Mimio Interactive Teaching Technologies

Headsprout EARLY READING

Episode	Featured Sounds & Sight Words*	Skills & Strategies
24	h, is, his, old**	establishing, segmenting, word reading
25	f, s, h, o	blending, decoding, word reading
26	sn, pl, s, o, h, sh, ish, is, his, the	sound production firming, blending, decoding, word reading, establishing, capitalization, sentence reading, reading comprehension
27	sw, w, ing	establishing, segmenting
28	w, ing, s, sw	blending, decoding, word reading, establishing, punctuation
29	fl, ing, h, s, his	blending, decoding, word reading, sentence reading, reading comprehension
30	p, ee, l, fl, ing, w, the, old, is, I, his	word reading, punctuation, story reading, reading comprehension
31	t, tr, st, er	establishing, segmenting
32	h, er, pl, an, t, sw, ee, her	blending, decoding, word reading3
33	tr, st, ish, sw, ee, p	segmenting, capitalization, blending, decoding, word reading
34	ish, ip, ing, fl, st, h, or, her, is	sound production firming, blending, decoding, word reading, nonsense-word decoding, sentence reading, reading comprehension
35	cl, sl, pr, could, would, should, sw, ip, n, ing,	sound production firming, establishing, word reading, blending, decoding, nonsense-word decoding
36	could, would, should	word reading
37	st, ing, f, ee, t, tr	blending, decoding, word reading
38	cr, ing, er, w, ish, s, fl	sound production firming, blending, decoding, word reading, nonsense-word decoding
39	sw, tr, st, w, t, should, could, would, the, see, her	sound production firming, blending, decoding, word reading, sentence reading, reading comprehension
40	ing, she, he, the, and, I, could	establishing, word reading, story reading, reading comprehension

Headsprout EARLY READING

Overview of Sounds and Sample Words

The systematic, contextually-based teaching of highly-stable phonetic elements in **Headsprout** ***Early Reading*** **Episodes 1-40** helps ensure that children read new words with confidence and success. The following sequence, tested extensively by children, has been found to be very effective in ensuring reading success.

	Phonetic Elements	Sample Words
Episodes 1-5 Space World	s, ee, v, an, n	see, van Sam*, Vee*, the
Episodes 6-11 Dino World	ol, o, l, fr, f, r, fl, or, sl, sn	Lee*, oan, feels, Fran*, fan, ran, sees flee, reel
Episodes 12-18 Sea World	ip, p, pl, pr, sp, and	I, and, out, flips, sand, Pip*, sleeps, clips, peep, Clee*, plan, reef, feel, rip, land, slip, peel, slips, free
Episodes 19-23 Jungle World	ish, sh, out	shouts, fish, ship, vanish, pout, ships, reefs, sheep
Episodes 24-30 Jungle World	h, sw, ing, w, old	old, is, his, folds, hand, cold, Scout*, hands, wings, swing, Fling*, fling, holds, wing
Episodes 31-40 Jungle World	t, er, tr, st	her, plant, sweet, Trish*, sweep, standing, could, would, should, sting, feet, tree, wish, sing, told she, he, hold, Blake

* *Headsprout character names*

As learners become fluent in the concepts of letters representing sounds and sounds making up words, **Headsprout** ***Early Reading*** **Episodes 41-80** incorporate less stable sounds and more opportunities for novel words.

	Phonetic Elements	Sample Words
Episodes 41-47 Jungle World	ike, ake, k, m, b, bl, br, d, dr	lake, like, flake, hike, Swish*, pan, cakes, pancakes, likes, take, bringing, seek, needs, makes, bake, Mike*, dish, slips, blank, drank, flipper, brings, takes, a, some
Episodes 48-56 Dino World	g, um, oo, z, or, j, im, in, ill, ay, th, thr, gr	good, soon, wood, tool, noon, took, food, foot, cooking, spoon, for, zoom, work, sank, book, looks, come, are, in, sang, long, said, wants, on, Tim*, jumps, look, jump, moon, too, word, drink, about, one, two, you, may, three, Jill*, grand, play, playing, thump

Headsprout®

now part of DYMO | Mimio®

Appendix B.

Recruitment Poster

Is your child having difficulty learning to read?

Title of Study: Using *HeadSprout Early Reading* to Develop Early Literacy Skills for Children with Autism Spectrum Disorder and Reading Difficulties

Purpose

The purpose of this research project is to consider the effectiveness of the HeadSprout program to teach a specific reading skill, phonological awareness, to children with ASD who are struggling learning to read, and to understand your child's engagement and enjoyment of the HeadSprout program.

What does Participation mean?

Should you choose to participate, you will be asked to attend Brock University Campus for an information session and asked if you would like your child to be assessed to see if they are eligible to participate. The expected duration of participation would be a 1 hour information session and assessment meeting in December 2013**.** The interview will include an introduction and review of the research project, outline details of the program and what participation includes. It will also include a 30 minute assessment of your child's phonological processing skills to determine if they are eligible to participate in the research project. Should your child qualify to participate, the research program will run three days a week for 9 weeks, with an anticipated start for January 2014.

Risks and Benefits

Minimal risks may affect participants by causing possible discomfort or frustration as a result of learning something new, or the possible inconvenience of bringing your child to Brock University for program sessions.

This research may benefit your child's reading development and may teach them foundational reading skills. This research may provide insight into how effective HeadSprout is at teaching reading skills to children with Autism Spectrum Disorder and explain why the program may be engaging and enjoyable to users.

Should you wish to participate, the researchers would like to invite you to an assessment meeting to see if your child is eligible to participate. Information and assessment meetings will be anticipated to take place December 2013.

If you have any pertinent questions about your rights as a research participant, please contact the Brock University Research Ethics Officer (905 688-5550 Ext. 3035, reb@brocku.ca)

If you have any questions regarding the research study or participation, please feel free to contact me (see below for contact information). If you would like to participate in an information session and assessment meeting, please contact me by **email** (listed below).
Thank you,

Caitlin Freeman
Principle Student Investigator
MA Candidate in Applied Disability Studies
(905) 931-6575
cf07ar@brocku.ca

Dr. John McNamara
Principle Co-Investigator
Child & Youth Studies
(905) 688-5550 Ext. 3835
john.mcnmara@brocku.ca

Dr. Tiffany Gallagher
Principle Co-Investigator
Faculty of Education
(905) 688-5550 Ext. 5114
tgallagher@brocku.ca

This study has been reviewed and received ethics clearance through Brock University's Research Ethics Board (#12-313).

Appendix C.

Letter of Invitation

Letter of Invitation **September 1st, 2013**

Title of Study: Using *HeadSprout Early Reading* to Develop Early Literacy Skills for Children with ASD and Reading Difficulties

Principal Investigator: Caitlin Freeman, MA Candidate, Centre for Applied Disability Studies, Brock University

Faculty Supervisor: Dr. John McNamara, Department of Child and Youth Studies, Brock University, and Dr. Tiffany Gallagher, Department of Faculty Education, Brock University

I, Caitlin Freeman, MA Candidate, from the Centre of Applied Disability Studies at Brock University, invite you to participate in a research project entitled: Using *HeadSprout Early Reading* to Develop Early Literacy Skills for Children with Autism Spectrum Disorder and Reading Difficulties.

Purpose

The purpose of this research project is to consider the effectiveness of the HeadSprout program to teach a specific reading skill, phonological awareness, to children with ASD who are struggling learning to read and to understand your child's engagement and enjoyment of the HeadSprout program.

Eligibility

Participants eligible to participate in the research must be:
- male or female between the ages of 4 and 8 years old
- diagnosed with Autism Spectrum Disorder
- demonstrate functional verbal ability at the sentence or phrase level
- demonstrate poor phonological awareness
- does not have an auditory processing difficulty

What does Participation mean?

Should you choose to participate, you will be asked to attend Brock University Campus for an information session and asked if you would like your child to be assessed to see if they are eligible to participate. The expected duration of participation would be a 1 hour information session and assessment meeting December, 2013**.** The interview will include an introduction and review of the research project, outline details of the program and what participation includes. It will also include a 30 minute assessment of your child's phonological processing skills to determine if they are eligible to participate in the research project.

Should your child qualify to participate, the research program will run three days a week for 9 weeks, with an anticipated start in January 2014. The research program will

include a 10 minute warm up activity, 30 minutes of reading instruction provided by the computer reading program *HeadSprout Early Reading,* followed by a 5 minute rating task completed by your child, and 10 minutes of one-on-one reading support. Book reading activities will follow closely to the *HeadSprout* program which teaches 6 reading skills that support reading development through a variety of interactive games and tasks.

Your participation is voluntary, and should you choose to withdraw from the study, you will be provided a copy of the *HeadSprout* program for continued use with your child.

Risks and Benefits

Minimal risks may affect participants by causing possible discomfort or frustration as a result of learning something new, or the possible inconvenience of bringing your child to Brock University for program sessions.

This research may benefit your child's reading development and may teach them foundational reading skills. This research may provide insight into how effective HeadSprout is at teaching reading skills to children with Autism Spectrum Disorder and explain why the program may be engaging and enjoyable to users.

This single-site research project is affiliated with Brock University and will run for 9 weeks beginning January 2014. Sessions will run three days a week and will be one hour in length.

If you have any questions regarding the research study or participation, please feel free to contact me (see below for contact information). If you would like to participate in an information session and assessment meeting, please contact me by **email (**see below).

If you have any pertinent questions about your rights as a research participant, please contact the Brock University Research Ethics Officer (905 688-5550 Ext. 3035, reb@brocku.ca)

Thank you,

Caitlin Freeman
Principle Student Investigator
MA Candidate in Applied Disability Studies
cf07ar@brocku.ca

Dr. John McNamara
Co- Student Advisor
Child & Youth Studies
(905) 688-5550 Ext. 3835
john.mcnmara@brocku.ca

Dr. Tiffany Gallagher
Co- Student Advisor
Faculty of Education
(905) 688-5550 Ext. 5114
tgallagher@brocku.ca

This study has been reviewed and received ethics clearance through Brock University's Research Ethics Board (#12-313).

Appendix D.

Assessment Meeting Consent Form

January 2014

Project Title: Using *HeadSprout Early Reading* to Develop Early Literacy Skills for Children with ASD and Reading Difficulties

Principle Student Investigator	Co-Student Advisor	Co-Student Advisor
Caitlin Freeman	Dr. John McNamara	Dr. Tiffany Gallagher
MA Candidate in Applied Disability Studies	Dept. of Child & Youth Studies	Dept. of Education
	(905) 688-5550 Ext. 3835	(905) 688-5550 Ext. 5114
cf07ar@brocku.ca	john.mcnmara@brocku.ca	tgallagher@brocku.ca

INVITATION

You are invited to participate in a study that involves research. The purpose of this research project is to consider the effectiveness, engagement, and enjoyment when using the HeadSprout program to teach a specific reading skill, phonological awareness, to children with ASD who are struggling learning to read. You are invited to an assessment meeting to determine if your child would be eligible to participate in this research project.

WHAT'S INVOLVED

As a participant, your child will be asked to answer a series of questions for assessment by the primary investigator. Assessment for participation eligibility will take approximately 45 minutes of your time today to assess your child's phonological processing skills to determine if they are eligible to participate in the research project.

If your child is eligible and you choose to participate in the research study, the program will run 3 times a week for 9 weeks.

POTENTIAL BENEFITS AND RISKS

Minimal risks may affect participants by causing possible discomfort or frustration as a result of learning something new, or the possible inconvenience of bringing your child to Brock University for program sessions. This risk will be managed by providing breaks to your child if needed, and providing reinforcement at the end of the assessment.

This research may benefit your child's reading development and may teach them foundational reading skills. This research may provide insight into how effective HeadSprout is at teaching reading skills to children with Autism Spectrum Disorder and explain why the program may be engaging, and enjoyable to users.

CONFIDENTIALITY

All data collected from participants will be treated as private. Data collected will have the associated participant names, but these names will not be associated with the results reported. All information you provide is considered confidential; your name will not be included or, in any other way associated with the data collected in the study. Access to this data will be restricted to individuals who have signed a Privacy and Confidentiality Agreement. All information and data will be stored in a locked cabinet within a research lab at Brock University. Data will be kept for 5 years after which time it will be shredded and destroyed.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time and may do so without any penalty or loss of benefits to which you are entitled.

PUBLICATION OF RESULTS

Results of the assessment will only be published should you consent. Results of the research study may be published in professional journals and presented at conferences. Feedback about this study will

be available in August 2014, and should you choose to have a copy, you may contact the Principle Investigator.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact Caitlin Freeman using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (#12-313). If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca

Thank you for your assistance in this project. Please keep a copy of this form for your records.

PARENT CONSENT

I agree to participate in the research program described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

By signing below I provide permission for my child, _____, to participate in the study described above, should he or she choose to participate.

Name: _____

Signature: _____ Date: _____

CHILD ASSENT

The researcher will ask the child the following questions:

1. Do you have any questions about participating in this program?
2. Do you have to participate in the program? (no)
3. What will happen if you decide you do not want to participate? (nothing)
4. Are you allowed to drop out and stop being a participant? (yes)
5. Are you allowed to drop out and stop using the data? (yes)
6. Do you agree to participate in the reading program?

Child Name: _____ Date: _____

I confirm that I have explained the study to the parent in sufficient detail to address all of their questions and concerns, and that the parent has agreed to be in the study. I confirm that the child gave verbal assent to participate in the research program.

Investigator's Name:_____ Signature:_____ Date:_____

Appendix E.

Program Letter of Invitation

Letter of Invitation: Your child has qualified to participate January 2014

Title of Study: Using *HeadSprout Early Reading* to Develop Early Literacy Skills for Children with Autism Spectrum Disorder and Reading Difficulties.

Principal Investigator: Caitlin Freeman, MA Candidate, Applied Disability Studies, Brock University

Faculty Supervisor: Dr. John McNamara, Child and Youth Studies, Brock University, and Dr. Tiffany Gallagher, Faculty Education, Brock University.

I, Caitlin Freeman, MA Candidate, from the Department of Applied Disability Studies, Brock University, invite you to participate in a research project entitled: Using *HeadSprout Early Reading* to Develop Early Literacy Skills for Children with Autism Spectrum Disorder and Reading Difficulties.

Purpose

The purpose of this research project is to consider the effectiveness of the HeadSprout program to teach a specific reading skill, phonological awareness, to children with ASD who are struggling learning to read, and to understand your child's engagement and enjoyment of the HeadSprout program.

What does Participation mean?

Should you choose to participate, your child will be asked to attend and participate in the HeadSprout program at Brock University 3 times a week for a duration of 1 hour. Within this hour, your child will be asked to participate in the following activities while being videotaped: 1) a 10 minute warm-up activity or game, 2) complete 30 minutes of HeadSprout Computer Programming, 3) asked to rate their enjoyment of the computer lesson, 4) read a book with the researcher, followed by, 5) playing or receiving a game/snack/toy for the session.

The program will run for 9 weeks. Program sessions will begin the week of April 7th, 2014 and will conclude the week of June 9th, 2014**.**

Risks and Benefits

Minimal risks may affect participants by causing possible discomfort or frustration as a result of learning something new, or the possible inconvenience of bringing your child to Brock University for program sessions. This risk will be managed by providing breaks to your child if needed, and providing reinforcement at the end of the assessment.

This research may benefit your child's reading development and may teach them foundational reading skills. This research may provide insight into how effective

HeadSprout is at teaching reading skills to children with Autism Spectrum Disorder and explain why the program may be engaging, and enjoyable to users.

This single-site research project is affiliated with Brock University**.**

Should you wish to participate in this research study, please contact Caitlin Freeman by:

Friday February 7th, 2014.

If you have any questions regarding the research study or participation, please feel free to contact me (see below for contact information). If you have any pertinent questions about your rights as a research participant, please contact the Brock University Research Ethics Officer (905 688-5550 Ext. 3035, reb@brocku.ca)

Thank you,

Caitlin Freeman
Principle Student Investigator
MA Candidate in Applied Disability Studies
cf07ar@brocku.ca

Dr. John McNamara
Co-Student Advisor
Dept. of Child & Youth Studies
(905) 688-5550 Ext. 3835
john.mcnmara@brocku.ca

Dr. Tiffany Gallagher
Co-Student Advisor
Dept. of Education
(905) 688-5550 Ext. 5114
tgallagher@brocku.ca

This study has been reviewed and received ethics clearance through Brock University's Research Ethics Board (#12-313).
http://www.brocku.ca/researchservices/Ethics_Safety/Humans/Index.php

Appendix F.

Program Consent Form

Please review prior to the first day of programming.

If your child decides to participate in the research project entitled "*Using HeadSprout Early Reading to Develop Early Literacy Skills for Children with ASD and Reading Difficulties",* please review the consent form, and ask any questions to the researchers prior to signing the form.

Project Title: Using *HeadSprout Early Reading* to Develop Early Literacy Skills for Children with ASD and Reading Difficulties

Principle Student Investigator	Co-Student Advisor	Co-Student Advisor
Caitlin Freeman	Dr. John McNamara	Dr. Tiffany Gallagher
MA Candidate in Applied Disability Studies	Dept. of Child & Youth Studies	Dept. of Education
	(905) 688-5550 Ext. 3835	(905) 688-5550 Ext. 5114
cf07ar@brocku.ca	john.mcnmara@brocku.ca	tgallagher@brocku.ca

INVITATION

You are invited to participate in a study that involves research. The purpose of this research project is to consider the effectiveness, engagement, and enjoyment when using the HeadSprout Early Reading program to teach a specific reading skill, phonological awareness, to children with ASD who are struggling learning to read. You and your child are invited to participate in this research project.

WHAT'S INVOLVED

As a participant, your child will attend a reading program 3 times a week for one hour each session. This program will run for 9 weeks, accumulating in a total of 27 program sessions. For each video-taped one hour session, your child will be asked to participate in the following: warm-up activities with the researcher, 30 minutes of the HeadSprout computer reading program, rating of the HeadSprout lesson, reading of the corresponding HeadSprout book, and a concluding game. The mid-point of the program will include an assessment of your child's phonological processing. Similarly, at the completion of the reading program, your child will be once again assessed for their phonological processing skills.

POTENTIAL BENEFITS AND RISKS

Research participation would help foster your child's reading development and teach them the skills needed to be a successful reader. Benefits to other children with Autism Spectrum Disorder (ASD) will result by identifying if HeadSprout is an effective method to teach reading skills specifically to children with ASD. Possible risks associated with participation may be discomfort, stress, or frustration as a result of not knowing the correct answer. This risk will be managed by providing breaks to your child if needed, and providing reinforcement at the end of the each activity.

CONFIDENTIALITY

All data collected from participants will be treated as private. Data collected will have the associated participant names, but these names will not be associated with the results reported. Program sessions will be video recorded to measure participant engagement, and for the purpose of monitoring treatment integrity. No personal identifiers associated with video and audio recordings will be reported. All information you provide is considered confidential; your name will not be included or, in any other way associated with the data collected in the study. Access to this data will be restricted to individuals who have signed a Privacy and Confidentiality Agreement. All information and data will be stored in a locked cabinet within a research lab at Brock University. Data will be kept for 5 years after which time it will be shredded and destroyed.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. If you wish, you may decline to answer any questions or participate in any component of the study. Further, you may decide to withdraw from this study at any time and may do so without any penalty or loss of benefits to which you are entitled. If you are unable to

attend a session your child's programming will be extended to a maximum of 1 week after the anticipated completion date. If your child misses more than 7 sessions, your child will be removed from the program. In such case, you will be entitled to the rest of your child's subscription to *HeadSprout Early Reading.*

PUBLICATION OF RESULTS

Results of the research study may be published in professional journals and presented at conferences. Feedback about this study will be available in August 2014, and should you choose to have a copy, you may contact the Principle Investigator.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact Caitlin Freeman using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (#12-313). If you have any comments or concerns about your rights as a research participant, please contact the Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca

Thank you for your assistance in this project. Please keep a copy of this form for your records.

PARENT CONSENT

I agree to participate in the research program described above. I have made this decision based on the information I have read in the Information-Consent Letter. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

By signing below, I provide permission for my child, _____, to participate in the study described above, should he or she choose to participate.

Name: _____

Signature: _____ Date: _____

CHILD ASSENT

The researcher will ask the child the following questions:

1. Do you have any questions about participating in this program?
2. Do you have to participate in the program? (No)
3. What will happen if you decide you do not want to participate? (Nothing)
4. Are you allowed to drop out and stop being a participant? (Yes)
5. Are you allowed to drop out and stop using the data? (Yes)
6. Do you agree to participate in the reading program?

Child Name: _____ Date: _____

I confirm that I have explained the study to the parent in sufficient detail to address all of their questions and concerns, and that the parent has agreed to be in the study. I confirm that the child gave verbal assent to participate in the research program.

Investigator's Name: _____ Signature:_____ Date:_____

Appendix G.

Pre-Program Preference Profile

Parents, please complete the following form with your child.

	QUESTION	PARENT RESPONSE	CHILD RESPONSE
1.	**What kind of activities do you enjoy?** Ex: draw, computer games, TV, sports…		
2.	**What activities are you good at?**		
3.	**What kinds of snacks or treats do you like?**		
4.	**What kind of drinks do you like?**		
5.	**What toys do you like to play with?** Ex: figurines, dolls, music (Ipod)…		
6.	**What toys are hard or not at all fun?**		
7.	**What snacks and drinks don't you like?**		
8.	**What activities are hard, not fun, or make you upset/mad/angry?**		

9.	**What fun activity would you want as a special treat?** Ex: movie, fun game/outing, pizza party…		
10.	**Do you like playing games on the computer?** 1 = No, not at all 2 = Rarely 3 = Sometimes/Okay 4 = A lot/ Often 5 = Love/Really like to		
11.	**How much experience do you have using the computer?** 1 = None / never 2 = Rarely (a couple times a month) 3 = Sometimes (couple times a week) 4 = Every day		

Appendix H.

Program Feedback Letter

Dear ***(Insert Name of Participant),*** Date: June 11, 2014

I would like to thank you for your participation in this study entitled "Using *HeadSprout Early Reading* to Develop Early Literacy Skills for Children with ASD and Reading Difficulties". As a reminder, the purpose of this study is to consider the effectiveness, engagement, motivation, and enjoyment when using the HeadSprout program to teach a specific reading skill, phonological awareness, to children with ASD who are struggling learning to read.

The data collected during the assessment interview and program sessions will contribute to a better understanding of the effectiveness of HeadSprout for children with ASD, but also the unique aspects of the HeadSprout program that may make the program enjoyable, and engaging to children with ASD.

Please remember that any data pertaining to you as an individual participant will be kept confidential. Once all the data are collected and analyzed for this project, I plan on sharing this information with my thesis committee and I may present non-identifying information in presentations at seminars and conferences. I intend to write up the results of this study for publication. If you are interested in receiving more information regarding the results of this study, or would like a copy of the publication, please provide your email address, and when the manuscript is completed, anticipated by August 2014**,** I will send you the information.

Now that the study is complete, if you have any other questions about the study, please do not hesitate to contact me by email or telephone as noted below.

Sincerely,

Caitlin Freeman
Principle Student Investigator
MA Candidate in Applied Disability Studies
cf07ar@brocku.ca

Dr. John McNamara
Co- Student Advisor
Child & Youth Studies
(905) 688-5550 Ext. 3835
john.mcnmara@brocku.ca

Dr. Tiffany Gallagher
Co- Student Advisor
Faculty of Education
(905) 688-5550 Ext. 5114
tgallagher@brocku.ca

Appendix I.

Contact and Basic Information Questionnaire

Dear parents, for research purposes we seek some basic information regarding your child. The reason we are collecting this information is to determine if your child will be an eligible candidate to participate in the research project. Please provide as much information as possible, and this information will remain confidential.

Date: (MM-DD-YYYY):	**Filled out by:**
Childs Name: (Last, First) ☐ **M** ☐ **F**	**DOB: (MM-DD-YYYY):**
CONTACT INFORMATION	
Primary Caregiver Name: (Last, First)	
Mothers Name: (Last, First)	**Mothers Marital Status:**
Fathers Name: (Last, First)	**Fathers Marital Status:**
Siblings: (Sex and age)	
Primary Contact: (Name, Address, Telephone Number)	
Emergency Contact: (Name, Address, Telephone Number)	
Is your son/daughter allergic to any drugs, foods, and/or medication? ☐ **NO** ☐ **YES, please specify (type of allergy & first aid required):**	
Does your son/daughter take any prescription drugs that we should be aware of? ☐ **NO** ☐ **YES, please specify:**	

ELIGIBILITY INFORMATION

Clinical Diagnoses of Autism Spectrum Disorder? □ **YES** □ **NO**

Attached documents supporting this diagnosis? □ **YES** □ **NO**

Has your child been diagnosed with any of the following:

- □ **Auditory Processing Difficulty**
- □ **Learning/Reading Disability**
- □ **Other Developmental Disability**
- □ **Hyperlexia**
- □ **Other:** _____

Additional Clinical Diagnoses? □ **NO** □ **YES, please specify:** _____

Education Type (Full-time/private/public/grade):

Support needed within school/learning environment:

Please describe your child's ability and level of support needed to use a computer:

_____

_____

Additional Comments:

_____

_____

_____

Research Contact Information:

Caitlin Freeman
Principal Student Investigator
MA Candidate in Applied Disability Studies
cf07ar@brocku.ca

Dr. John McNamara
Co- Student Advisor
Child & Youth Studies
(905) 688-5550 Ext. 3835
john.mcnmara@brocku.ca

Dr. Tiffany Gallagher
Co- Student Advisor
Faculty of Education
(905) 688-5550 Ext. 5114
tgallagher@brocku.ca

Brock University Research Ethics Officer: 905 688-5550 Ext. 3035, reb@brocku.ca

Appendix J.

Momentary Time Sampling: Perceived Engagement

Engagement

Engagement will be operationally defined as a percentage of time on-task. Specifically, engagement and on-task behaviour will determined by observing and recording if the child's eyes are on the computer screen indicating that the child is interacting with the HeadSprout computer program.

Engagement will be quantified using a momentary time sampling procedure with 15-second intervals (Cooper, Heron, & Heward, 2007). At the start of the observation period, the observer will start the 15 second timer. When 15 seconds has passed, the observer will look at the child and record if the child is on-task (eyes on computer screen) or off-task (motor, verbal, or passive).

Behaviour Definitions

1) On-task: if the child is looking at the screen, looking down to click the mouse, dancing to music and song

2) Off-task Motor (**Motor**): if the child is off-task, and is engaging in motor activity. Example: the child is rocking in the chair, not looking at the screen.

3) Off-task Vocal (**Vocal**): if the child is off-task, and is engaging in vocal activity. Example the child scripts or repeats the instructions, or talks to the researcher about an unrelated topic/question.

4) Off-task Passive (**Passive**): if the child is off-task, does not appear to be doing anything, or is passive. Example: the child looks away during instructions

Momentary Time Sampling: Perceived Engagement

Observer Instructions:

1. Start the video (at the time indicated by Caitlin).
3. When the time on the video matches the time on the data sheet, look at the child:

a) if the child is looking at the screen, looking down to click the mouse, dancing to music and song, place an X in the *On-task* box.

b) If the child is off-task, and is engaging in motor activity, place an X in the *Off-task (motor)* box.

c) If the child is off-task, and is engaging in vocal activity, place an X in the *Off-task (vocal)* box.

d) If the child is off-task, and does not appear to be doing anything, or is passive, place an X in the *Off-task (passive)* box.

4. Continue this procedure for the entire designated time as shown on the data recording sheet
5. Pause and rewind if necessary to ensure correct coding.

***Note:** if a child is on-task for 75% or more of the time, it will be said that the child is engaged

Participant Code:		001
Observer:		
Video File #		Video X

Time interval		On-task	Off: Motor	Off: Vocal	Off: Passive	Time interval		On-task	Off: Motor	Off: Vocal	Off: Passive	Time Interval		On-task	Off: Motor	Off: Vocal	Off: Passive	Time Interval		On-task	Off: Motor	Off: Vocal	Off: Passive
1	:30					31	8:00					61	15:30					91	23:00				
2	:45					32	8:15					62	15:45					92	23:15				
3	1:00					33	8:30					63	16:00										
4	1:15					34	8:45					64	16:15										
5	1:30					35	9:00					65	16:30										
6	1:45					36	9:15					66	16:45										
7	2:00					37	9:30					67	17:00										
8	2:15					38	9:45					68	17:15										
9	2:30					39	10:00					69	17:30										
10	2:45					40	10:15					70	17:45										
11	3:00					41	10:30					71	18:00										
12	3:15					42	10:45					72	18:15										
13	3:30					43	11:00					73	18:30										
14	3:45					44	11:15					74	18:45										
15	4:00					45	11:30					75	19:00										
16	4:15					46	11:45					76	19:15										
17	4:30					47	12:00					77	19:30										
18	4:45					48	12:15					78	19:45										
19	5:00					49	12:30					79	20:00										
20	5:15					50	12:45					80	20:15										
21	5:30					51	13:00					81	20:30										
22	5:45					52	13:15					82	20:45										
23	6:00					53	13:30					83	21:00										
24	6:15					54	13:45					84	21:15										
25	6:30					55	14:00					85	21:30										
26	6:45					56	14:15					86	21:45										
27	7:00					57	14:30					87	22:00										
28	7:15					58	14:45					88	22:15										
29	7:30					59	15:00					89	22:30										
30	7:45					60	15:15					90	22:45										

Scoring:		On-task	Off: Motor	Off: Vocal	Off: Passive			On-task	Total Off-task
	Total Count	/92	/92	/92	/92		Total Count	/92	/92
	Percent	%	%	%	%		Percent	%	%

Appendix K.

Sample Interobserver Agreement Coding Form

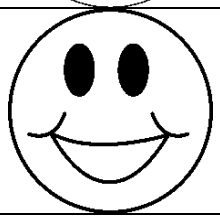
Participant Code:		001
Observer:		Researcher, Second Observer
Video File #		Training Video A

Time interval		On-task	Off: Motor	Off: Vocal	Off: Passive	Time interval		On-task	Off: Motor	Off: Vocal	Off: Passive	Time Interval		On-task	Off: Motor	Off: Vocal	Off: Passive	Time Interval		On-task	Off: Motor	Off: Vocal	Off: Passive
1	:30	Xx				31	8:00	X X				61	15:30	X X				91	23:00	Xx			
2	:45	Xx				32	8:15	X			X	62	15:45	X X				92	23:15	xx			
3	1:00	Xx				33	8:30	X X				63	16:00	Xx				93					
4	1:15	Xx				34	8:45	X X				64	16:15	X X				94					
5	1:30	Xx				35	9:00	X X				65	16:30	X X				95					
6	1:45	Xx				36	9:15			X X		66	16:45	X X x				96					
7	2:00	Xx				37	9:30	X X				67	17:00	X X				97					
8	2:15	Xx				38	9:45	X X				68	17:15	X X				98					
9	2:30	Xx				39	10:00	X X				69	17:30	X X				99					
10	2:45	Xx				40	10:15	X X				70	17:45	X X				100					
11	3:00	Xx				41	10:30	X*		X		71	18:00	X X				101					
12	3:15	Xx				42	10:45				XX	72	18:15	X X				102					
13	3:30	Xx				43	11:00	X X				73	18:30	X X				103					
14	3:45	Xx				44	11:15	X X				74	18:45	X X				104					
15	4:00	Xx				45	11:30	X X				75	19:00	X X				105					
16	4:15	Xx				46	11:45	X X				76	19:15	X X				106					
17	4:30	Xx				47	12:00	X X				77	19:30	X X				107					
18	4:45	X		X		48	12:15	X X				78	19:45	X X				108					
19	5:00			Xx		49	12:30	X X				79	20:00	X X				109					
20	5:15	Xx				50	12:45	X X				80	20:15			Xx		110					
21	5:30	X X				51	13:00	X X				81	20:30	Xx				111					
22	5:45	X X				52	13:15	X X				82	20:45	Xx				112					
23	6:00	X X				53	13:30	X X				83	21:00	Xx				113					
24	6:15	X X				54	13:45	X X				84	21:15	Xx				114					
25	6:30		XX			55	14:00	X X				85	21:30	Xx				115					
26	6:45	X X				56	14:15	X X				86	21:45	Xx				116					
27	7:00	X X				57	14:30	X X				87	22:00	Xx				117					
28	7:15	X		X		58	14:45	X X				88	22:15	Xx				118					
29	7:30	X X				59	15:00	X X				89	22:30	Xx				119					
30	7:45	x X				60	15:15	X X				90	22:45	Xx				120					

Agreements	Disagreements	Total # of Intervals	Interobserver Agreement
88	4	92	**88/** 92 = **95.6%**

Appendix L.

Participant Self-Rating Enjoyment Scale

	I did not enjoy this activity at all, I do not want to do it again.	☆
	I did not enjoy this activity, it was boring	☆ ☆
	I thought the activity was okay.	☆ ☆ ☆
	I liked the activity.	☆ ☆ ☆ ☆
	I loved the activity, and want to do it again	☆ ☆ ☆ ☆ ☆

Appendix M.

Participant Self-Rating Enjoyment Data Sheet

The self-report measures will consist of giving each participant a file folder with Velcro spots to place up to 5 gold stars, after having completed the HeadSprout lesson. Each participant will be instructed and assisted to use the rating scale as a reflection of their enjoyment of the HeadSprout lesson. After each session is complete, the researcher will record the student's rating of the HeadSprout lesson on the following data sheet.

The following scale will be used:
1= I did not enjoy this activity at all, I do not want to do it again.
2 = I did not enjoy this activity, it was boring.
3 = I thought the activity was okay.
4 = I liked the activity.
5 = I loved the activity, and want to do it again

Participant Enjoyment Rating of HeadSprout Program							
			Participant's Rating				
Date	Session #	HeadSprout Episodes Covered	* Poor	** Boring	*** Okay	**** Good	***** Excellent
	1						
	2						
	3						
	4						
	5						
	6						
	7						
	8						
	9						
	10						
	11						
	12						
	13						
	14						
	15						
	16						
	17						
	18						
	19						
	20						
	21						
	22						
	23						
	24						
	25						
	26						
	27						

Appendix N.

Researcher Field Notes

Date: _____ **Session #: _____**

Specific Activity	Notes
Warm-up Activity	
Computer Program	
Rating of Program	What did you like most about our work today?
	What did you like least about our work today?

Reading with Reinforcement	
Reinforcer Selection	
Overall Session Reflection	

Appendix O.

Perceived Enjoyment, Engagement and Level of Assistance during HeadSprout Activities

Instructions: Perceived engagement and enjoyment will be observed during the HeadSprout lesson using the perceived engagement and enjoyment observation sheet. During the 30 minute HeadSprout lesson, the primary researcher will record the type of activity at the start of each new activity. Throughout each activity, the primary researcher will rate the level of assistance required, and perceived enjoyment and perceived engagement. The observer will continue this process for each activity, throughout the remainder of the HeadSprout computer lesson.

Each day, a total rating percentage will be calculated and graphed for each of the 3 variables being rated (Difficulty/help required, enjoyment, and engagement).

Operational Definitions for Engagement

1 = Child appeared to never be on-task (10% or less of the time)
2 = Child appeared to rarely be on-task (20-39% of the time)
3 = Child appeared to sometimes be on-task (40-59% of the time)
4 = Child appeared to mostly be on-task (60-79% of the time)
5 = Child appeared to always be on-task (80% or higher).

Operational Definitions for Perceived Enjoyment

1 = Participant did not appear to enjoy this activity at all, and does not appear to want to do it again
2 = Participant did not appear to enjoy this activity, it was boring
3 = Participant appeared to think the activity was okay
4 = Participant appeared to like the activity
5 = Participant appeared to love the activity, and would want to do it again.

Operational Definitions for Level of Assistance Required

1 = Child needed constant assistance to complete the task (7 or more prompts per activity)
2 = Child needed significant assistance to complete task (5-6 or more prompts per activity)
3 = Child needed some assistance to complete task (3-4 prompts per activity)
4 = Child rarely needed help to complete task (1-2 prompts per activity)
5 = No help was required from researcher to complete the activity.

Perceived Enjoyment, Engagement and Level of Assistance during HeadSprout Activities
Daily Data Sheet

Participant:			
Date:			
Lesson Number:			
	1 = constant assistance (7+ pr) 2= Needs signif. assistance: 5-6 pr 3 = Some assistance (3-4 prompts) 4 = Rarely needs help (1-2 pr) 5 = No help required (0)	1 = Poor 2 = Boring 3 = Okay 4 = Good 5 = Loved it	1 = Never on-task (10% or less) 2 = Rarely on-task (20-39%) 3 = Sometimes (40-59%) 4 = Mostly on-task (60-79%) 5 = Always on-task (80% +)
Activity Type	**Level of Assistance Required**	**Enjoyment**	**Engagement**
Average Daily Rating			

Appendix P.

Field Note Reminder Sheet

Please observe and reflect on the following areas/topics throughout the program session:

a) Warm-up activities: reflect on participant mood, activities used, enjoyment and interaction with activities, enjoyment and interaction with researcher, other factors that may influence the session

b) Computer program (30 minutes): in addition to the observed ratings data collection, write and reflect on factors influencing student performance, type of activities, difficulty with a specific word, etc.

c) Rating of computer program: reflect on student's ability to reflect on the computer session, their ability to complete this with or without assistance, etc.

d) Reinforcement with Book Reading: reflect on participant's engagement with the book, areas of difficulty, enjoyment, type of reinforcement used, level of support needed, how the participant reacts to support and/or feedback, specific prompting or teaching strategies that work or do not work

e) Selected Reinforcement: what does the participant select for completion of the session

f) Overall session reflection: a brief statement or two to summarize the session

Appendix Q.

Reflective Researcher Journal

Session: _____ Date: _____

What instruction types work well, what do not
'Now what'. How can we use this knowledge to help the student in the future (p. 8-11)
Critically analyze and grapple with theory and practice: think of how this fits into professional attitudes and practice – long term connections to the broader field of education and ABA.

Appendix R.

Second Observer Privacy and Confidentiality Agreement

General Statement of Confidentiality
Research Assistants and Transcribers
Name of Research Assistant/Transcriber: Whitney Kerr

Title(s) of Research Study: Using HeadSprout Early Reading to Develop Early Literacy Skills for a Child with Autism Spectrum Disorder and Reading Difficulties

An important part of conducting research is having respect for privacy and confidentiality. In signing below, you are agreeing to respect the participant's right to privacy and that of the people and organizations that may be included in the information collected. Such information may include interviews, questionnaires, diaries, audiotapes, and videotapes. You are asked to respect people's right to confidentially by not discussing the information collected in public, with friends or family members. The study and its participants are to be discussed only during research meetings with the Principal Investigators, Co-Investigators, Program Manager, and/or others identified by the Investigators.

In signing below, you are indicating that you understand the following:

- I understand the importance of providing anonymity (if relevant) and confidentiality to research participants.
- I understand that the research information may contain references to individuals or organizations in the community, other than the participant. I understand that this information is to be kept confidential.
- I understand that the information collected is not to be discussed or communicated outside of research meetings with the Principal Investigators, Co-Investigators or others specifically identified by the Investigators.
- When transcribing audio or videotapes (where applicable), I will be the only one to hear the tapes and I will store these tapes and transcripts in a secure location at all times.
- I understand that the data files (electronic and hard copy) are to be secured at all times (e.g., not left unattended) and returned to the Principal Investigator when the transcription process is complete.

In signing my name below, I agree to the above statements and promise to guarantee the anonymity (if relevant) and confidentiality of the research participants

Signature of Research Assistant/Transcriber: _____

Date: May 31, 2014

Used from Brock University Ethics Board
http://www.brocku.ca/webfm_send/1014

Appendix S.

Treatment Integrity Form

Session # _____ Rater Initials:_____ Date: _____

Coding: √ if opportunity available, or completed correctly
X if incorrectly implemented
N/A if not applicable, or opportunity not available

	Procedural Steps	Opportunities	Correctly Implemented
1	**Arrival:** Greet the parent(s) and participant(s) check-in with regard to consent	√	√
2	**Warm-Up Activity:** Instruct participant to choose from a pool of activities or games to play with the researcher	√	√
3	**HeadSprout:** a. Participant completes 30 minutes of the HeadSprout program	√	√
4	b. Researcher records observation notes	√	√
5	**Support during HeadSprout:** a. Researcher correctly prompts a response if participant does not respond within 5 seconds during computer lesson	√	√
6	**Rating of HeadSprout**: a. Researcher reviews the rules for rating	√	√
7	b. Researcher assists participant in rating, without providing a response for them	√	√
8	**Book Reading** a. Participant reads the corresponding HeadSprout book from the most recently completed lesson	√	√
9	b. Researcher correctly prompts a response if participant does not respond within 3 seconds while reading the book	√	√
10	c. Researcher prompts least to most	√	**X**
11	d. Researcher uses modeling when necessary	√	√
12	e. Researcher provides reinforcement in the form of positive statements and gestures (i.e. high-five)	√	√
13	**Reinforcement Activity/Snack /Toy:** Participant selects a reinforcing activity/toy/snack	√	√
14	**Session Wrap-Up:** a. Researcher follows-up with parents, discusses the skill targets for the day and the child's progress.	√	√
15	b. Researcher asks questions If there are any note-worthy observations about a child's behavior	N/A	N/A
	Total Count	**13**	**14**
	Percent Treatment Integrity	**92.86 %**	

Appendix T.

HeadSprout Episode Map

Appendix U.

Confidence Intervals for CTOPP Scores

Confidence Intervals for Pre Test Raw Scores and Raw Composite Scores

			Score Range		
	Raw Score	**Standard Error**	**68% Confidence**	**95% Confidence** (SE * 1.96)	**99% Confidence** (SE * 2.58)
PAC	85	4	81 - 89	77 - 93	75 - 95
A-PAC	82	4	78 - 86	74 - 90	72 - 92
Elision	4	1	3 - 5	0 - 8	0 - 11
Blend Words	6	1	5 - 7	2 - 10	0 - 13
Blend Nonwords	4	1	3 - 5	0 - 8	0 - 11
Segment Words	0	1	0 - 1	0 - 4	0 - 7
Segment Nonwords	2	1	1 - 3	0 - 6	0 - 9

Confidence Intervals for Mid Test Raw Scores and Raw Composite Scores

			Score Range		
	Raw Score	**Standard Error**	**68% Confidence**	**95% Confidence** (SE * 1.96)	**99% Confidence** (SE * 2.58)
PAC	85	4	81 - 89	77 - 93	75 - 95
A-PAC	85	4	81 - 89	77 - 93	75 - 95
Elision	4	1	3 - 5	0 - 8	0 - 11
Blend Words	7	1	6 - 8	3 - 11	0 - 14
Blend Nonwords	5	1	4 - 6	1 - 9	0 - 12
Segment Words	0	1	0 – 1	0 - 4	0 - 7
Segment Nonwords	2	1	1 - 3	0 - 6	0 - 9

Confidence Intervals for Post Test Raw Scores and Raw Composite Scores

			Score Range		
	Raw Score	**Standard Error**	**68% Confidence**	**95% Confidence** (SE * 1.96)	**99% Confidence** (SE * 2.58)
PAC	94	4	90 - 98	86 - 102	84 - 104
A-PAC	85	4	81 - 89	77 - 93	75 - 95
Elision	6	1	5 - 7	2 - 10	0 - 13
Blend Words	8	1	7 - 9	4 - 12	1 - 15
Blend Nonwords	8	1	7 – 9	4 - 12	1 - 15
Segment Words	5	1	4 – 6	1 - 9	0 - 12
Segment Nonwords	0	1	0 - 1	0 - 4	0 - 7

Ethics Materials

Brock University
Research Ethics Office
Tel: 905-688-5550 ext. 3035
Email: reb@brocku.ca

Social Science Research Ethics Board

Certificate of Ethics Clearance for Human Participant Research

DATE:	8/20/2013		
PRINCIPAL INVESTIGATOR:	MCNAMARA, John Applied Disability Studies		
FILE:	12-313 - MCNAMARA		
TYPE:	Masters Thesis/Project	STUDENT: SUPERVISOR:	Caitlin Freeman John McNamara

TITLE: Using MimioSprout Early Reading to Develop Early Literacy Skills for Children with Autism Spectrum Disorder and Reading Difficulties

ETHICS CLEARANCE GRANTED

Type of Clearance: NEW Expiry Date: 8/29/2014

The Brock University Social Sciences Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement. Clearance granted from 8/20/2013 to 8/29/2014.

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the expiry date, you are required to submit a Renewal form before 8/29/2014. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page at http://www.brocku.ca/research/policies-and-forms/research-forms.

In addition, throughout your research, you must report promptly to the REB:

a) Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) All adverse and/or unanticipated experiences or events that may have real or potential unfavourable implications for participants;
c) New information that may adversely affect the safety of the participants or the conduct of the study;
d) Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved:

Jan Frijters, Chair
Social Sciences Research Ethics Board

Note: Brock University is accountable for the research carried out in its own jurisdiction or under its auspices and may refuse certain research even though the REB has found it ethically acceptable.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of research at that site.

Brock University
Research Ethics Office
Tel: 905-688-5550 ext. 3035
Email: reb@brocku.ca

Social Science Research Ethics Board

Certificate of Ethics Clearance for Human Participant Research

DATE: April 1, 2014

PRINCIPAL INVESTIGATOR: MCNAMARA, John - Applied Disability Studies

FILE: 12-313 - MCNAMARA

TYPE: Masters Thesis/Project STUDENT: Caitlin Freeman
SUPERVISOR: John McNamara

TITLE: Using MimioSprout Early Reading to Develop Early Literacy Skills for Children with Autism Spectrum Disorder and Reading Difficulties

ETHICS CLEARANCE GRANTED

Type of Clearance: MODIFICATION Expiry Date: 8/29/2014

The Brock University Social Sciences Research Ethics Board has reviewed the above named research proposal and considers the procedures, as described by the applicant, to conform to the University's ethical standards and the Tri-Council Policy Statement. Clearance granted from 4/1/2014 to 8/29/2014.

The Tri-Council Policy Statement requires that ongoing research be monitored by, at a minimum, an annual report. Should your project extend beyond the expiry date, you are required to submit a Renewal form before 8/29/2014. Continued clearance is contingent on timely submission of reports.

To comply with the Tri-Council Policy Statement, you must also submit a final report upon completion of your project. All report forms can be found on the Research Ethics web page at http://www.brocku.ca/research/policies-and-forms/research-forms.

In addition, throughout your research, you must report promptly to the REB:

a) Changes increasing the risk to the participant(s) and/or affecting significantly the conduct of the study;
b) All adverse and/or unanticipated experiences or events that may have real or potential unfavourable implications for participants;
c) New information that may adversely affect the safety of the participants or the conduct of the study;
d) Any changes in your source of funding or new funding to a previously unfunded project.

We wish you success with your research.

Approved:

Jan Frijters, Chair
Social Sciences Research Ethics Board

Note: Brock University is accountable for the research carried out in its own jurisdiction or under its auspices and may refuse certain research even though the REB has found it ethically acceptable.

If research participants are in the care of a health facility, at a school, or other institution or community organization, it is the responsibility of the Principal Investigator to ensure that the ethical guidelines and clearance of those facilities or institutions are obtained and filed with the REB prior to the initiation of research at that site.